Università degli Studi dell'Aquila

Non-Cooperative Networks: Mid-term Evaluation

Tuesday, November 7th, 2017 – Prof. Guido Proietti

Write your data $\Longrightarrow$	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. A *Dominant Strategy Equilibrium* is a strategy combination $s^* = (s_1^*, \ldots, s_N^*)$, such that (assume p_i is a utility):
   a) there exists a player i and an alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, such that $p_i(s_1, \ldots, s_i^*, \ldots, s_N) \leq p_i(s_1, \ldots, s_i, \ldots, s_N)$
   *b) for each player i and for any possible alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, $p_i(s_1, \ldots, s_i^*, \ldots, s_N) \geq p_i(s_1, \ldots, s_i, \ldots, s_N)$
   c) there exist no player i and no alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, such that $p_i(s_1, \ldots, s_i^*, \ldots, s_N) \geq p_i(s_1, \ldots, s_i, \ldots, s_N)$
   d) for each player i and for any possible alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, $p_i(s_1^*, \ldots, s_i^*, \ldots, s_N^*) \leq p_i(s_1, \ldots, s_i, \ldots, s_N)$
2. A *Nash Equilibrium* is a strategy combination $s^* = (s_1^*, \ldots, s_N^*)$, such that (assume p_i is a cost):
   a) there exists a player i and an alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, such that $p_i(s_1, \ldots, s_i^*, \ldots, s_N) \geq p_i(s_1, \ldots, s_i, \ldots, s_N)$
   b) for each player i and for any possible alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, $p_i(s_1, \ldots, s_i^*, \ldots, s_N) \leq p_i(s_1, \ldots, s_i, \ldots, s_N)$
   c) there exist no player i and no alternative strategy profile $s = (s_1, \ldots, s_i, \ldots, s_N)$, such that $p_i(s_1, \ldots, s_i^*, \ldots, s_N) \geq p_i(s_1, \ldots, s_i, \ldots, s_N)$
   *d) for each player i and for any alternative strategy s_i of i, $p_i(s_1^*, \ldots, s_i^*, \ldots, s_N^*) \leq p_i(s_1^*, \ldots, s_i, \ldots, s_N^*)$
3. How the Price of Anarchy is defined for a game in which the social choice function C has to be maximized (S is the set of Nash equilibria)?
   a) $\text{PoA} = \sup_{s \in S} \frac{C(s)}{C(\text{OPT})}$ *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) $\text{PoA} = \inf_{s \in S} \frac{C(\text{OPT})}{C(s)}$
4. How the Price of Stability is defined for a game in which the social-choice function C has to be minimized (S is the set of Nash equilibria)?
   a) $\text{PoS} = \sup_{s \in S} \frac{C(s)}{C(\text{OPT})}$ *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. In a network with k players and linear latency functions, which of the following claim on the selfish routing game is true?
   a) The PoS is at least 4/3 b) The PoS is at most 1 *c) The PoA is at least 4/3 d) The PoA is at most k, and this is tight
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 $\alpha = 3/2$, PoS $= 1$ b) for $\alpha = 1$, the clique is the only stable graph c) PoA $= O(1)$ *d) PoS $\leq 4/3$
8. Which of the following is a Clarke payment scheme?
   a) $p_i(g(r)) = \sum_{j \neq i} v_j(r_j, g(r_{-i})) - \sum_{j \neq i} v_j(r_j, g(r))$ b) $p_i(g(r)) = -\sum_{j \neq i} v_j(r_j, g(r)) + \sum_j v_j(r_j, g(r))$
   *c) $p_i(g(r)) = -\sum_{j \neq i} v_j(r_j, g(r_{-i})) + \sum_{j \neq i} v_j(r_j, g(r))$ d) $p_i(g(r)) = -\sum_j v_j(r_j, g(r_{-i})) + \sum_{j \neq i} v_j(r_j, g(r))$
9. In the Malik, Mittal and Gupta algorithm for the selfish-edge shortest path problem, which of the following keys is associated with a node y in the priority queue when an edge e of a graph $G = (V, E)$ is considered?
   a) $k(y) = \min_{(x,y) \in E, x \in N_s(e)} \{d_G(s, x) + r(x, y) + d_G(y, z)\}$ b) $k(y) = \max_{(x,y) \in E, x \in M_s(e)} \{d_G(s, x) + r(x, y) + d_G(y, z)\}$
   *c) $k(y) = \min_{(x,y) \in E, x \in M_s(e)} \{d_G(s, x) + r(x, y) + d_G(y, z)\}$ d) $k(y) = \min_{(x,y) \in E, x \in M_s(e)} \{d_G(s, x) + 1 + d_G(y, z)\}$
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 three questions, and address it exhaustively.

1. Describe and analyze the selfish routing game.
2. Describe and analyze the global connection game.
3. Describe and analyze the VCG-mechanism for the single-edge single-pair shortest path problem.