Algorithmic Game Theory
Assignment 7

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1. Which of the following can be computed using a no-external regret algorithm?
   (a) An ε-correlated equilibrium.
   (b) An ε-coarse correlated equilibrium.
   (c) A correlated equilibrium.
   (d) A coarse correlated equilibrium.

   The correct answer is (b).
   Justification: Refer to week-7 lecture-2

2. Which of the following can be computed using a no-swap regret algorithm?
   (a) An ε-correlated equilibrium.
   (b) An ε-coarse correlated equilibrium.
   (c) A correlated equilibrium.
   (d) A coarse correlated equilibrium.

   The correct answer is (a).

3. Consider the following battle of sexes game.
   - ▷ The set of players $(N) : \{1, 2\}$
   - ▷ The set of strategies: $S_i = \{A, B\}$ for every $i \in [2]$
   - ▷ Payoff matrix:

		Player 2	
		A	B
Player 1	A	$(1, 2)$	$(0, 0)$
	B	$(0, 0)$	$(2, 1)$

   Compute the price of anarchy of this game with respect to PSNEs? Answer range: 0.58 to 1.45

4. Consider the following coordination game.
   - ▷ The set of players $(N) : \{1, 2\}$
   - ▷ The set of strategies: $S_i = \{A, B\}$ for every $i \in [2]$
   - ▷ Payoff matrix:

		Player 2	
		A	B
Player 1	A	$(10, 10)$	$(0, 0)$
	B	$(0, 0)$	$(1, 1)$

   Compute the price of anarchy of this game with respect to PSNEs? Answer range: 7.5 to 12.5

5. Consider the following coordination game.
   - ▷ The set of players $(N) : \{1, 2\}$
   - ▷ The set of strategies: $S_i = \{A, B\}$ for every $i \in [2]$

▷ Payoff matrix:

		Player 2	
		A	B
Player 1	A	$(10, 10)$	$(0, 0)$
	B	$(0, 0)$	$(1, 1)$

Compute the security of this game with respect to pure strategies? Answer range: -2.5 to 2.5

6. Consider the following prisoner's dilemma game.

▷ The set of players $(N) : \{1, 2\}$

▷ The set of strategies: $S_i = \{C, NC\}$ for every $i \in [2]$

▷ Payoff matrix:

		Player 2	
		C	NC
Player 1	C	$(-5, -5)$	$(-1, -10)$
	NC	$(-10, -1)$	$(-2, -2)$

Compute the price of anarchy of this game with respect to PSNEs? Answer range: 0.32 to 0.48.

7. Suppose we have a no-swap regret algorithm with time-averaged swap regret being $R(T, n)$. How many iterations of this no-swap regret algorithm per player is enough to compute an ε-CE of a strategic form game with 17 players and 19 strategies per player?

(a) $R\left(\frac{1}{\varepsilon}, 17\right)$

(b) $R\left(\frac{1}{\varepsilon}, 19\right)$

(c) $\min\{t \in \mathbb{N} : R(t, 17) \leqslant \varepsilon\}$

(d) $\min\{t \in \mathbb{N} : R(t, 19) \leqslant \varepsilon\}$

The correct answer is (d).
Justification: Refer to week-7 lecture-2

8. Suppose we have a no-external regret algorithm with time-averaged swap regret being $R(T, n)$. How many iterations of this no-swap regret algorithm per player is enough to compute an ε-CE of a strategic form game with 17 players and 19 strategies per player?

(a) $R\left(\frac{1}{\varepsilon}, 17\right)$

(b) $R\left(\frac{1}{\varepsilon}, 19\right)$

(c) $\min\{t \in \mathbb{N} : R(t, 17) \leqslant \varepsilon\}$

(d) $\min\{t \in \mathbb{N} : R(t, 19) \leqslant \varepsilon\}$

The correct answer is (d).
Justification: Refer to week-7 lecture-2 and lecture-3

9. Which of the following statements is correct?

(a) Every no-external regret algorithm is also a no-swap regret algorithm.

(b) Every no-swap regret algorithm is also a no-external regret algorithm

(c) No no-external regret algorithm is a no-swap regret algorithm.

(d) No no-swap regret algorithm is a no-external regret algorithm

The correct answer is (b).

10. Which of the following statements is wrong?

(a) There exists a black-box reduction from no-external regret algorithm to no-swap regret algorithm

(b) There exists a black-box reduction from no-swap regret algorithm to no-external regret algorithm

(c) Existence of an algorithm with time-averaged external regret being at most $\frac{\log n}{T}$ implies existence of an algorithm with time-averaged swap regret being at most $\frac{\log n}{T}$

(d) Existence of an algorithm with time-averaged swap regret being at most $\frac{\log n}{T}$ implies existence of an algorithm with time-averaged external regret being at most $\frac{\log n}{T}$

The correct answer is (c).
Justification: Refer to week-7 lecture-3