Università degli Studi dell'Aquila

Distributed Systems: 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. Let $f(n)$ and $g(n)$ denote the message complexity of the *Chang & Roberts* algorithm in the worst and in the average case, respectively. Which of the following asymptotic relations is wrong?
*a) $f(n) = \Theta(g(n))$ b) $f(n) = \Omega(g(n))$ c) $f(n) = \omega(g(n))$ *d) $f(n) = O(g(n))$

2. Assume that in the *Hirshberg & Sinclair* algorithm, a processor p_i is trying to elect itself as temporary leader during phase $k \geq 0$. What is the maximum number of messages that will be generated by p_i in this phase?
*a) $4 \cdot 2^k$ b) $2^k + 2$ c) 2^{k+1} d) 2^k

3. Let be given a synchronous, non-anonymous, non-uniform ring with 5 processors, with maximum identifier equal to 10. In the worst case, the most efficient *leader election* algorithm will terminate after a number of rounds equal to:
a) 30 b) it does not exist *c) 35 d) 55

4. Let us consider the asynchronous version of the *Prim* algorithm. Which of the following claim is false?
a) In each phase, each node sends at most a single *Report* message
*b) In each phase, each node sends and then receives at most a single *Test* followed by a *Reject*
c) In each phase, each node receives at most a single *Search_MOE* message
d) In each phase, each node sends at most a single *Connect* message

5. Let $f(n)$ and $g(n)$ denote the message complexity of the asynchronous versions of the *Prim* and the *GHS* algorithm, respectively, when executed on a dense graph, i.e., with $m = \Theta(n^2)$. Which of the following asymptotic relations is correct?
a) $f(n) = \Theta(g(n) \cdot n)$ *b) $f(n) = \Theta(g(n))$ c) $f(n) = \Theta(g(n) \cdot \log n)$ d) $f(n) = \omega(g(n))$

6. (**canceled**) Let us consider the synchronous version of the *GHS* algorithm. Which of the following claim is true?
a) In each phase, each node sends and then receives exactly a single *Test* followed by an *Accept*
b) In each phase, each node sends and then receives at most a single *Test* followed by a *Reject*
c) In each phase, each node receives $\Theta(n)$ *Test* messages
d) In each phase, each node sends and then receives exactly a single *Test* followed by a *Reject*

7. Let us consider the asynchronous version of the *GHS* algorithm. Which of the following claim is true?
a) Each time the level of its fragment increase, a node receives at most a single *Report* message
*b) There will be a total of $\Theta(n)$ *Connect* messages
c) There will be a total of $O(n)$ *Test-Reject* messages
d) Each node sends at most a single *Merge* message

8. The randomized algorithm for finding a *maximal independent set* running on a graph with n nodes and with degree $\Theta(n)$, with high probability has a number of phases in the order of:
*a) $O(n \log n)$ b) $O(1)$ c) $\Theta(\sqrt{n})$ d) $\Theta(n \log n)$

9. Let A and B be optimization problems, and let $OPT_A()$ and $OPT_B()$ denote their optimal solutions. Given an L-reduction from A to B with functions f and g, which of the following conditions must be true?
*a) there exists a positive constant α such that for every instance x of A, $OPT_B(f(x)) \leq \alpha\, OPT_A(x)$;
b) there exists a positive constant α such that for every instance x of A, $OPT_B(x) \leq \alpha\, OPT_A(x)$;
c) there exists a positive constant α such that for every instance x of A, $OPT_B(g(x)) \leq \alpha\, OPT_A(x)$;
d) there exists a positive constant α such that for every instance x of A, $OPT_B(f(x)) \leq \alpha\, OPT_A(g(x))$.

10. Let G be an n-vertex graph of degree Δ. What is the approximation ratio guaranteed by the greedy algorithm for the *minimum dominating set* problem?
*a) $H(\Delta + 1)$ b) $H(\ln \Delta + 1)$ c) $\ln(H(\Delta))$ d) Δ

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 Hirshberg & Sinclair algorithm for the *leader election* problem.

2. Describe and analyze the synchronous version of the Gallager, Humblet e Spira (GHS) algorithm for the *minimum spanning tree* problem.