Università degli Studi dell'Aquila

Distributed Systems: Mid-term Evaluation

Tuesday, November 5th, 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. Let $f(n)$ and $g(n)$ denote the message complexity of the *Chang & Roberts* algorithm in the average and in the worst case, respectively. Which of the following asymptotic relations is wrong?
*a) $f(n) = \Theta(g(n))$ b) $f(n) = O(g(n))$ c) $f(n) = o(g(n))$ d) $g(n) = \Omega(g(n))$

2. Specify the largest among the following classes of rings for which the *leader election* problem can be solved through the *Hirshberger & Sinclair* algorithm:
a) asynchronous, anonymous, uniform, no-synchronized start b) synchronous, non-anonymous, uniform, no-synchronized start c) asynchronous, non-anonymous, uniform, synchronized start *d) asynchronous, non-anonymous, uniform, no-synchronized start

3. 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 <u>maximum</u> 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

4. Let us consider the *leader election* algorithm for a synchronous ring with n processors, non-anonymous and uniform. Let the minimum id in the ring be equal to 2^n. Then, the algorithm has a number of rounds of:
a) $O(n \cdot 2^n)$ b) $O(1)$ *c) $O(n \cdot 2^{2^n})$ d) $\Theta(n)$

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

6. 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) $f(n) = \Theta(g(n))$ b) $f(n) = \omega(g(n))$ c) $f(n) = \Theta(g(n) \cdot \log n)$ d) $f(n) = o(g(n))$

7. Let us consider the synchronous version of the *GHS* algorithm. Which of the following claim is true?
a) In each phase, each node sends $\Theta(n)$ *Reject* messages
b) In each phase, each node sends $\Theta(1)$ *Test* messages
*c) In each phase, each node receives $O(n)$ *Test* messages
d) In each phase, each node sends and then receives $\Theta(1)$ *Test* messages followed by a *Reject*

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

9. The Luby algorithm for finding a *maximal independent set* running on a graph with n nodes and with maximum degree $\Theta(1)$, with high probability has a number of phases in the order of:
a) $\Theta(\log^2 n)$ b) $O(1)$ c) $\Theta(n \log n)$ *d) $O(\log n)$

10. Which of the following claim is true for the $(\Delta + 1)$-coloring algorithm, when $\Delta = \Theta(\log n)$:
a) It terminates within $O(\log^2 n)$ rounds;
*b) It terminates within $O(\log \log n \log^2 n)$ rounds w.h.p.;
c) It terminates within $O(\log \log n \log n)$ rounds w.h.p.;
d) It terminates within $O(\log^3 n)$ rounds w.h.p.

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 *slow-fast message* algorithm for the leader election problem.
2. Describe and analyze the synchronous version of the *GHS* algorithm for the minimum spanning tree problem.