Università degli Studi dell'Aquila

Distributed Systems: Mid-term Evaluation

Tuesday, November 17th, 2020 – 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 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) $g(n) = O(f(n))$
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 minimum 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. The most efficient *leader election* algorithm in a synchronous, non-anonymous, uniform n-nodes ring, has a number of rounds of:
   a) $\Theta(n)$ *b) $O(n \cdot 2^L)$, where L is the lowest id in the ring
   c) $O(n \cdot 2^L)$, where L is the largest id in the ring d) $O(n \cdot L)$, where L is the leader id
4. Let be given a synchronous, non-anonymous, non-uniform ring with 10 processors, and with maximum identifier equal to 9. The most efficient *leader election* algorithm will terminate after a number of rounds equal to:
   a) 1 b) it does not exist *c) 10 d) 100
5. Let us consider the asynchronous version of the *Prim* algorithm. Which of the following claim is false?
   a) In each phase, a node can receive $\Theta(n)$ *Report* messages
   *b) In each phase, each node sends at most a single *Test* message
   c) In each phase, each node receives exactly a single *Search_MOE* message
   *d) In each phase, each node sends exactly 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 sparse graph, i.e., with $m = \Theta(n)$. Which of the following asymptotic relations is correct?
   a) $f(n) = \Theta(g(n) \cdot \log n)$ b) $f(n) = \Theta(g(n))$ c) $f(n) = O(g(n))$ *d) $f(n) = \omega(g(n))$
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 and then receives exactly a single *Test* followed by an *Accept*
   *b) In each phase, each node sends $O(n)$ *Test* messages
   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*
8. 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
9. In the first randomized algorithm for finding a *maximal independent set*, which of the following is the definition of a *bad event* for the input graph?
   *a) After $\Theta(\ln n)$ phases, at least one node did not disappear b) After $\Theta(1)$ phases, at least one node did not disappear
   c) After $\Theta(\ln n)$ phases, $\Theta(n)$ nodes did not disappear d) After $\Theta(\ln n)$ phases, one node did not disappear
10. The Luby algorithm for finding a *maximal independent set* running on a graph with n nodes and with maximum degree $\Theta(\log n)$, with high probability has a number of phases in the order of:
    a) $O(1)$ b) $O(\log n)$ *c) $O(\log n \log\log n)$ d) $\Theta(\log^2 n)$

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 GHS algorithm for the *minimum spanning tree* problem.