Università degli Studi dell'Aquila

Distributed Systems: Mid-term Evaluation

Tuesday, November 9th, 2021 – 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 $f(n)$ denote the message complexity in the average case of the *Chang & Roberts* algorithm, and let $g(n)$ denote the message complexity in the worst case of the *Hirshberg & Sinclair* algorithm, respectively. Which of the following asymptotic relations is correct?
   *a) $f(n) = \Theta(g(n))$ b) $f(n) = o(g(n))$ c) $f(n) = \omega(g(n))$ d) $f(n) = g(n)$
2. Let $f(n)$ and $g(n)$ denote the message complexity of the *Hirshberg & Sinclair* algorithm in the best 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) $g(n) = \Omega(f(n))$
3. In the first phase of the *Hirshberg & Sinclair* algorithm, how many messages are sent at most, assuming that all processors start simultaneously?
   a) $n/2$ b) n c) $2n$ *d) $4n$
4. The most efficient *leader election* algorithm in a synchronous, non-anonymous, non-uniform n-nodes ring, has a number of rounds of:
   a) $\Theta(n)$ b) $\Theta(n \cdot 2^L)$, where L is the lowest id in the ring
   c) $\Theta(n \cdot 2^L)$, where L is the largest id in the ring *d) $O(n \cdot L)$, where L is the lowest id in the ring
5. Let us consider the asynchronous version of the *Prim* algorithm. Which of the following claim is true?
   a) In each phase, each node sends more than 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 an *Accept*
   c) In each phase, each node sends 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) $f(n) = \Theta(g(n) \cdot n)$ *b) $f(n) = \Theta(g(n))$ c) $f(n) = \Theta(g(n) \cdot \log n)$ d) $f(n) = \omega(g(n))$
7. Throghout the execution of the asyncronous GHS algorithm, the maximum number of absorptions is:
   a) $n-1$ b) $O(1)$ *c) $n-2$ d) $\Theta(\log n)$
8. In the first randomized algorithm for finding a *maximal independent set*, which of the following is the definition of a *good event* for the input graph?
   *a) Within $\Theta(\ln n)$ phases, all nodes disappear b) After $\Theta(1)$ phases, at least one node disappears
   c) Within $\Theta(\ln n)$ phases, $\Theta(n)$ nodes disappear d) After $\Theta(\ln n)$ phases, $\Theta(\ln n)$ nodes disappear
9. The Luby algorithm for finding a *maximal independent set* running on a graph with n nodes and with maximum degree $\Theta(n)$, with high probability has a number of phases in the order of:
   a) $O(\log n)$ b) $O(1)$ c) $\Theta(n \log n)$ *d) $O(\log^2 n)$
10. Let us assume that the size of the *minimum dominating set* of a graph G with n vertices is k, and let k' be the size of a dominating set returned by the greedy algorithm. Which of the following asymptotic relations is true?
    *a) $k' = O(k \ln n)$ b) $k' = O(k)$ c) $k' = \omega(k \ln n)$ d) $k' = \Theta(k)$

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 the Chang & Roberts algorithm for the *leader election* problem, by providing a complete anaysis of the best, worst and average case
2. Describe the *maximal independent set* problem, by providing and analyzing at least one distributed algorithm to solve it