Università degli Studi dell'Aquila

Distributed Systems: Mid-term Evaluation

Tuesday, November 8th, 2016 – Prof. Guido Proietti

Write your data ⟹	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 awards 3 points, while a wrong answer awards a -1 penalization. The final result will be given by summing up all the obtained points (0 for a missing answer), by normalizing on a 20 base.

1. Let $f(n)$ and $g(n)$ denote the message complexity of the *Chang & Roberts* algorithm in the best and in the average 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. Assume that in the *Hirshberger & Sinclair* algorithm, a processor p_i is trying to elect itself as temporary leader during phase $k \geq 0$. What is the <u>minimum</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

3. The most efficient *leader election* algorithm for a synchronous ring with n processors, non-anonymous, uniform, non-synchronous start, with minimum id m, has a message complexity of:
   a) $\Theta(n \cdot 2^m)$ b) it does not exist c) $\Theta(n \cdot m)$ *d) $\Theta(n)$

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

5. Let us consider the synchronous version of the *GHS* 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 *New_Fragment* message
   d) In each phase, each node sends at most a single *Connect* message

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

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

8. Given a graph G, which of the following problems cannot be solved in polynomial time, unless P=NP?
   a) Finding a maximal independent set of G
   *b) Finding a maximum independent set of G
   c) Finding a dominating set of G
   d) Finding a minimum independent set of G

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

10. Let us consider the synchronous version of the greedy algorithm for computing a minimum dominating set of a graph G of n vertices and m edges. In the first phase, assuming that all the nodes will start at the same time, how many messages are generated (in total) by the nodes in order to compute their span?
    a) $\Theta(n^2)$ *b) $\Theta(m)$ c) $O(1)$ d) $O(n)$

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 randomized algorithm for the *maximal independent set* problem.

2. Describe and analyze the synchronous version of the Prim algorithm for the *minimum spanning tree* problem.