Università degli Studi dell'Aquila

Algorithms for Distributed Systems: Mid-term Evaluation

Wednesday, November 27th, 2013 – Prof. Guido Proietti

Write your data ⟹	Last name: .... First name: .... ID number:	Points
EXERCISE 1		
EXERCISE 2		
EXERCISE 3		
TOTAL		

EXERCISE 1: Multiple-choice questions (10 points)
Remark: Only one choice is correct. Use the enclosed grid to select your choice. A correct answer will make you gain 3 points, while a wrong answer will charge you with 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 10 base.

1. Let $f(n)$ and $g(n)$ denote the message complexity of the *Chang & Roberts* algorithm in the best and in the worst case, respectively. Which of the following asymptotic relations is wrong?
   *a) $f(n) = \Theta(g(n) \cdot n)$ *b) $f(n) = \Theta(g(n))$ c) $f(n) = o(g(n))$ d) $f(n) = O(g(n))$
2. Let $f(n)$ and $g(n)$ denote the message complexity of the *Chang & Roberts* and the *Hirshberger & Sinclair* algorithm in the average and in the worst case, respectively. 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) $f(n) = \omega(g(n))$
3. Let us consider the *leader election* algorithm we studied 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) $\Theta(2^n)$ b) $O(1)$ *c) $\Theta(n \cdot 2^n)$ d) $\Theta(n)$
4. Let us consider the first round of the synchronous version of the *Prim* algorithm on n processors. Then, in the worst case, how many messages will be sent in such a round?
   a) n b) $n-1$ *c) $O(1)$ d) no message is sent
5. Let us consider the first phase of the synchronous version of the *GHS* algorithm on n processors. Then, in the worst case, how many rounds the phase consists of?
   a) exactly n b) $O(1)$ *c) $\Theta(n)$ d) $O(\log n)$
6. Let $f(n)$ and $g(n)$ denote the message complexity of the asynchronous version 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) $f(n) = o(g(n))$ *d) $f(n) = \omega(g(n))$
7. The randomized algorithm for finding a *maximal independent set* running on a graph with n nodes and with degree $d = O(1)$, with high probability ends within a number of rounds in the order of:
   *a) $O(\log n)$ b) $O(1)$ c) $O(n)$ d) $O(n \log n)$
8. Let be given a synchronous n-processor system, with at most 1 crash failure. Assume that all the processors have a different input. Then, how many messages are totally sent during the execution of the 1-resilient to crash failures consensus algorithm?
   *a) $\Theta(n^3)$ b) $\Theta(n^2)$ c) $\Theta(n)$ d) $\Theta(1)$
9. Let be given a synchronous n-processor system, with at most 1 Byzantine failure. Assume that all the processors have a same input. Then, how many messages are totally sent during the execution of the 1-resilient King's algorithm?
   a) $\Theta(n^3)$ *b) $\Theta(n^2)$ c) $\Theta(n)$ d) $\Theta(1)$
10. In the *exponential-tree* algorithm with n processors, how many messages are sent during round d?
    a) $O(n)$ b) $O(n^2)$ c) $O(n^d)$ *d) $O(n^{d+1})$

Answer Grid

	Question									
Choice	1	2	3	4	5	6	7	8	9	10
a										
b										
c										
d										

EXERCISE 2: Open questions (10 points)
Remark: Select at your choice one out of the following two questions, and address it exhaustively.

1. Describe and analyze the *Chang & Roberts* algorithm.
2. Prove that there is no 1-resilient to Byzantine failures algorithm for 3 processors.

EXERCISE 3: Algorithm (10 points: 5 for the correctness, 3 for the efficiency, and 2 for the analysis)
Design an algorithm for a non-uniform, non-anonymous, synchronous MPS $G = (V, E)$, with synchronous start, which computes for each processor the length of the longest cycle in G the processor belongs to (assume that rounds are of *send-receive-compute* type).