Università degli Studi di L'Aquila

Algorithms for Distributed Systems: Mid-term Evaluation

Wednesday, November 23rd, 2011 – 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 provide you with 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. In a *non-anonymous* MPS, processors:
a) know the total number of processors b) are all identical c) do not know the total number of processors *d) have distinct ids
2. In which of the following cases the *leader election* problem cannot be solved:
a) asynchronous, non-anonymous and uniform ring b) synchronous, non-anonymous and non-uniform ring c) asynchronous, non-anonymous and non-uniform ring *d) synchronous, anonymous and non-uniform ring
3. In the *Hirshberger-Sinclair algorithm*, the number of messages in phase i is at most:
a) $4 \cdot 2^{i-1} \cdot \frac{n}{2^{i-1}+1}$ *b) $2^{i+2} \cdot \frac{n}{2^{i-1}+1}$ c) n d) $4 \cdot 2^{i} \cdot \frac{n}{2^{i+1}+1}$
4. In the synchronous version of the *Prim algorithm*, the number of rounds in phase i is at most:
a) $3n$ b) $O(1)$ *c) $O(n)$ d) $\Theta(\log n)$
5. In the *GHS algorithm*, the number of messages passing through an edge not belonging to the minimum spanning tree is:
a) $\Theta(\log n)$ *b) $O(1)$ c) $\Theta(n)$ d) $\Theta(n \log n)$
6. The randomized algorithm for finding a *maximal independent set* of a graph with n nodes of degree d, with probability at least $1 - 1/n$, ends within a number of phases in the order of:
a) $O(\log n)$ b) $O(1)$ c) $O(d)$ *d) $O(d \log n)$
7. Let be given a synchronous n-processor system, with at most f benign failures. Assume that all non-faulty processors have input x, while the minimum input among the faulty processors is $y < x$. Then, which of the following output is *non-admissible* for the consensus algorithm consisting of $f + 1$ round?
a) x b) y *c) $z < y$ d) $y < z < x$
8. If Byzantine processors do not send any message during the execution, what is the message complexity of the *Phase King* f-resilient algorithm?
a) $\Theta(n)$ *b) $\Theta(n^2 f)$ c) $\Theta(n^2)$ d) $\Theta(nf)$
9. Let be given a synchronous system of 17 processors, out of which at most 4 can be Byzantine. What is the minimum number of messages received by a non-faulty processor in a phase of the *Phase King* 4-resilient algorithm?
a) 14 *b) 13 c) 17 d) 0
10. In the *exponential-tree* f-resilient algorithm, the number of messages sent during the last round is:
a) $O(n^2)$ *b) $O(n^{f+2})$ c) $O(1)$ d) $\Theta(n)$

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 synchronous version of the *Prim algorithm*.
2. Describe and analyze the randomized synchronous algorithm for computing a *maximal independent set*.

EXERCISE 3: Algorithm (10 points: 5 for the correctness, 3 for the efficiency, and 2 for the analysis)

Design an algorithm for the consensus problems, by assuming that the underlying clique-system contains 10 processors, out of which at most 2 are Byzantine, and by modifying the validity assumption as follows: if all the non-faulty processors have the same integer number as input, then the output must be the smallest odd number greater than that input.