Università degli Studi di L'Aquila

Algorithms for Distributed Systems: Mid-term Evaluation

Wednesday, November 28th, 2012 – Prof. Guido Proietti

Write your data $\Longrightarrow$	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 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 uniform ring
2. What is the probability that id i makes exactly k steps in the *Chang&Roberts* algorithm, assuming that ids are in $[1..n]$?
   a) $P(i,k) = \frac{\binom{n-1}{k-1}}{\binom{i-1}{k-1}} \frac{n-i}{k}$ b) $P(i,k) = \frac{\binom{i-1}{k-1}}{\binom{n-1}{k-1}} \frac{n-1}{n-k}$ c) $P(i,k) = \frac{\binom{n-1}{k-1}}{\binom{i-1}{k-1}} \frac{n-i}{n-k}$ *d) $P(i,k) = \frac{\binom{i-1}{k-1}}{\binom{n-1}{k-1}} \frac{n-i}{n-k}$;
3. The most efficient *leader election* algorithm for a synchronous ring with n processors, non-anonymous and uniform, with minimum id m, has a number of rounds of:
   a) $\Theta(n \cdot m)$ b) it does not exist *c) $\Theta(n \cdot 2^m)$ d) $\Theta(n)$
4. In the synchronous *GHS algorithm* on n processors, the number of *New Fragment* messages sent by a node during a phase is:
   a) n b) $O(1)$ *c) $O(n)$ d) $\Theta(\log n)$
5. In the asynchronous *GHS algorithm* on n processors, the maximum number of *absorptions* is:
   a) $n-1$ *b) $n-2$ c) n d) $\lceil n/2 \rceil$
6. The randomized algorithm for finding a *maximal independent set* running on a clique graph with n nodes, with high probability ends within a number of rounds in the order of:
   a) $O(\log n)$ b) $O(1)$ c) $O(n)$ *d) $O(n \log n)$
7. Let be given a synchronous n-processor system, with at most $n-1$ benign failures. Assume that all the processors have a same input x, and that no processor crashes. Then, how many messages are sent during the execution of the consensus algorithm consisting of n rounds?
   a) n^3 b) n *c) n^2 d) $n(n-1)$
8. Let be given a synchronous system of 13 processors, out of which at most 3 are Byzantine. In the *Phase King* 3-resilient algorithm, assume that Byzantine processors are never kings. What is the *minimum* total number of messages sent during the whole execution?
   a) 39 b) 429 *c) 568 d) 0
9. In the *exponential-tree* f-resilient algorithm with n processors, assume that half of the processors has input 0, and the other half has input 1. Then, the output is:
   a) default value '*' *b) either 0, 1, or '*' c) 0 d) 1
10. In the *bakery algorithm* with n processors, a processor in the entry section that has already chosen its number, before entering the critical section can be preceded by at most the following number of processors:
    a) 0 *b) $n-1$ c) k, with k constant 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 *King's phase algorithm*.
2. Describe and analyze the *bakery algorithm*.

EXERCISE 3: Algorithm (10 points: 5 for the correctness, 3 for the efficiency, and 2 for the analysis)
Design an algorithm for a synchronous MPS $G = (V, E)$, with synchronous start, which ends with the following outputs: 1 for each processor p_i such that p_i is on a *triangle* in G, namely there exist p_j and p_k such that p_i, p_j and p_k are mutually adjacent in G, and 0 otherwise (i.e., p_i is not on a triangle in G).