Università degli Studi di L'Aquila

Algorithms for Distributed Systems: Mid-term Evaluation

Wednesday 9th of December, 2009 – 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 *uniform* 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. 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 message complexity 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*, the average number of rounds in a phase is:
   a) n b) $O(1)$ c) $O(\log n)$ *d) $5n + 2$
5. In the *GHS algorithm*, the number of messages passing through an edge **not belonging** to the minimum spanning tree is:
   *a) $O(\log n)$ b) $O(1)$ c) $\log n$ 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 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 $x > 0$, while the minimum input among the faulty processors is $y > x$. Then, which of the following is the output of the consensus algorithm consisting of $f + 1$ round?
   a) 0 b) y *c) x d) $z > y$
8. 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* algorithm?
   a) 14 *b) 13 c) 17 d) 0
9. In the *Bakery algorithm* for a system of 2 processors, a `number` variable can be at most:
   a) 1 b) 2 *c) unbounded d) 0
10. In the *tournament algorithm*, a processor before accessing the critical section can be overtaken by at most a number of processors equal to:
    *a) unbounded b) $n - 2$ 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 **any one of the two** questions at your convenience, and address it exhaustively.

1. Describe and analyze the *Hirschberg&Sinclair* leader election algorithm.
2. Describe and analyze the synchronous *GHS* algorithm.

EXERCISE 3: Algorithm (10 points)

Design an algorithm for the consensus problems, by assuming that the underlying system is a 3-processor fault-free, and by modifying the validity assumption in the following way: if there are at least 2 processors having the same input, then this must be the output.