Università degli Studi dell'Aquila

Distributed Systems: Mid-term Evaluation

Tuesday, November 24th, 2015 – Prof. Guido Proietti

Write your data $\Longrightarrow$	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 average and in the worst 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. Specify the largest among the following classes of rings for which the *leader election* problem can be solved through the *Hirshberger & Sinclair* algorithm:
   a) asynchronous, anonymous, uniform, no-synchronized start b) synchronous, non-anonymous, uniform, no-synchronized start
   c) asynchronous, non-anonymous, uniform, synchronized start *d) asynchronous, non-anonymous, uniform, no-synchronized start

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) n b) it does not exist c) $\Theta(n \cdot m)$ *d) $\Theta(n)$

4. Let us consider the *leader election* algorithm 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) $O(n \cdot 2^n)$ b) $O(1)$ *c) $O(n \cdot 2^{2^n})$ d) $\Theta(n)$

5. 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 dense graph, i.e., with $m = \Theta(n^2)$. 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) $f(n) = \omega(g(n))$

6. Let $f(n)$ and $g(n)$ denote the asymptotic number of rounds of the synchronous versions of the *Prim* and the *GHS* algorithm, respectively. Which of the following asymptotic relations is wrong?
   a) $g(n) = O(f(n))$ *b) $f(n) = \Theta(g(n))$ c) $f(n) = \Omega(g(n))$ 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 $\Theta(\sqrt{n})$, with high probability has a number of phases in the order of:
   *a) $O(\sqrt{n} \log n)$ b) $O(1)$ c) $O(\sqrt{n})$ d) $\Theta(n \log n)$

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

9. In the *bakery algorithm* with n processors, which of the following is the second semaphore of the entry section of p_i?
   a) wait until $\texttt{Choosing}[j] = \texttt{false}$ or $(\texttt{Number}[j], j) > (\texttt{Number}[i], i)$ *b) wait until $\texttt{Number}[j] = 0$ or $(\texttt{Number}[j], j) > (\texttt{Number}[i], i)$
   c) wait until $\texttt{Choosing}[j] = \texttt{false}$ d) wait until $\texttt{Number}[j] = 0$ or $(\texttt{Number}[j], j) < (\texttt{Number}[i], i)$

10. In the bounded-space 2-processor *Mutex algorithm* with no lockout, which of the following is the first semaphore of the entry section of p_i?
    *a) wait until $\texttt{W}[1 - i] = 0$ or $\texttt{Priority} = i$ b) wait until $\texttt{W}[1 - i] = 1$ or $\texttt{Priority} = i$
    c) wait until $\texttt{W}[1 - i] = 0$ or $\texttt{Priority} = 1 - i$ d) wait until $\texttt{Priority} = i$

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 *slow-fast message* algorithm for the leader election problem.

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