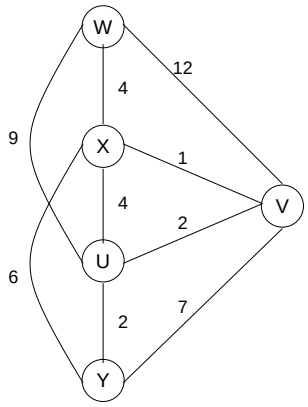
Exam Distributed Algorithms

Free University Amsterdam, 29 May 2007, 12:00-14:45

(At this exam, you may use copies of the slides without handwritten comments. Answers can be given in English or Dutch. Use of textbook, handouts, laptop is not *allowed.)*

(The exercises in this exam sum up to 90 points; each student gets 10 points bonus.)

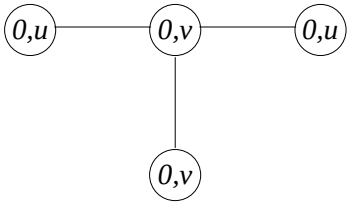
1. Run the Merlin-Segall algorithm on the undirected weighted graph below, to compute all shortest paths towards the node Y.



   Give a scenario that takes four update rounds before the correct sink tree has been computed. (12 pts)

2. Give an example to show that the Dijkstra-Feijen-van Gasteren algorithm for termination detection in a unidirectional network does not work in case of asynchronous communication. (6 pts)

3. Apply the echo algorithm with extinction to elect a leader in the following anonymous undirected network, where initial random identities have been chosen (and each process is at level 0). All processes are initiators, and know that the network size is 4.



Let $u < v$. Give a scenario in which the process at the bottom becomes the leader at level 1. Explain why, in such a scenario, at most one of the nodes $(0, u)$ will progress to level 1. (10 pts)

4. Given an undirected weighted graph in which all edges have a different weight. Explain in detail why the Gallager-Humblet-Spira algorithm for computing a minimal spanning tree will not deadlock on such an input graph. (10 pts)

5. Consider a complete network G (i.e., there is a channel between each pair of different processes) of five processes. Let three processes hold the value 0, while two processes hold the value 1. Apply the Bracha-Toueg algorithm for 2-crash consensus to G. Give two scenarios: one scenario where all correct processes decide 0, and one scenario where all correct processes decide 1. (10 pts)

6. Consider the Pease-Shostak-Lamport Byzantine broadcast algorithm. Determine the worst-case message complexity of $Broadcast_g(N, t)$. (10 pts)

7. Suppose that in the total bandwidth server, the formula for updating the deadline for a new head of the aperiodic job queue would be changed into

$$d := d + \frac{e}{\tilde{u}_s}$$

(instead of $d := \max(d, t) + \frac{e}{\tilde{u}_s}$). Give an example to show that then, in case of an EDF scheduler, a periodic job may miss its deadline. (10 pts)

8. Explain in detail why Raymond's algorithm for mutual exclusion provides *no starvation*. (10 pts)

9. Adapt Lamport's bakery algorithm for mutual exclusion such that the range of the *number* registers becomes finite. (12 pts)