Problem Set 6, Part b

Due: Thursday, December 3, 2015

Readings:

Borowsky, Gafni, Lynch, Rajsbaum paper.
Attiya, Welch book, Section 5.3.2
Attie, Guerraoui, Kouznetsov, Lynch, Rajsbaum paper
Lynch book, Chapter 17
Lamport's "Part-Time Parliament" paper (the "Paxos" paper)

Rest of term:
Failure detector papers by Chandra and co-workers and by Sastry and co-workers
Dolev's Self-Stabilization book, Chapter 2
Ghaffari, Lynch, Musco, Radeva paper on ant house-hunting

Problems:

5. Consider the following decision problem, which we call the ϵ-*approximation problem*, where ϵ is a positive real. The value domain V is $[0, 1]$, which is the set of real numbers between 0 and 1 inclusive. For any input vector I of elements of V, the allowable output vectors are those vectors O for which (i) every element in O is in the range of the values in I, and (ii) the difference between any two values in O is at most ϵ.
   (a) Consider an asynchronous read/write shared-memory system with n processes (for sufficiently large n) and at most one stopping failure. Describe a very simple algorithm A that solves the ϵ-approximation problem for this model, for any fixed, known ϵ. Explain why your algorithm is correct. How large a value of n do you need?
   (b) Now consider an asynchronous read/write shared-memory system with 2 processes and at most one stopping failure. Design an algorithm B for this model that solves the ϵ-approximation problem, for any fixed, known ϵ. Use the BG transformation. Explain clearly how you are applying this transformation and why it works properly.

6. Exercise 17.10.

   Extend the *ABDObject* algorithm so that it implements a multi-writer/multi-reader read/write atomic object, guaranteeing f-failure termination, if $n > 2f$. Show how to incorporate this extension into a fault-tolerant asynchronous network simulation of the shared memory model with multi-writer/multi-reader shared registers.

7. In the first phase of the Paxos consensus algorithm, a participating process i performs a step whereby it abstains from an entire group of ballots at once, namely, the set B of all ballots whose identifiers are strictly less than some particular proposed ballot identifier b, and that i has not already voted for. This set B may include ballots that have not yet been created.

   Suppose that, instead, process i simply abstained from all ballots in the set B that it knows have already been created. Does the algorithm still guarantee the agreement property? If so, give a convincing argument. If not, give a counterexample execution.