FDS 12: Problem Set 4:
Immediate Snapshot and Iterated Immediate Snapshot

A (one-shot) immediate snapshot (IS) object exports one operation $WriteRead_i(v)$ to every process p_i that takes a value as an argument and returns a vector S of N values, one value per process in response. In each run, IS ensures the following properties (here v_i denotes the value proposed by process p_i and S_i denotes the vector returned to p_i in that run):

- *Self-inclusion*: for all i, $v_i \in S_i$
- *Containment*: for all i, j: $S_i \subseteq S_j \vee S_j \subseteq S_i$
- *Immediacy*: for all i, j: if $v_i \in S_j$, then $S_i \subseteq S_j$

Exercise 4.1

Prove that the algorithm in slide 34 implements an IS (e.g., using the outline proposed in the slides).

Exercise 4.2

Would the algorithm be still correct if instead of $A_r.update_i(v_i)$ and $S := A_r.snapshot()$ we use

$$U_r[i].write(v_i)$$

and

$$S := scan(U_r[1], \ldots, U_r[N])$$

respectively, where U_r is a shared vector of N one-writer-N-reader atomic registers? Justify your judgement.

Exercise 4.3

Consider the simulation of (multiple-shot) AS in the iterated IS (IIS) model (slide 26 in Class 6). Complete the proofs of the following claims (e.g., using the outline proposed in the slides):

Lemma 2 *Let c_r and c'_r be the clock vectors evaluated by processes p_i and p_j, resp., in round r. Then $|c_r| \leq |c'_r|$ implies $c_r \leq c'_r$.*

Corollary 1 *All processes that complete a snapshot operation in round r, get the same clock vector c, $|c| = r$*

Corollary 2 *If a process completes a snapshot operation in round r with clock vector c, then for each clock vector c' evaluated in round $r' \geq r$, we have $c \leq c'$.*