Dr. Annette Bieniusa, Dr. Viktor Vafeiadis Winter term 2019/20

Lecture: Replication and Consistency
Exercise Sheet 3
`https://pl.cs.uni-kl.de/homepage/de/teaching/ws19/rac/`

1 Axiomatic semantics for Sequential Consistency

Give a proof that the two axiomatic definitions of sequential consistency from the lecture are equivalent.

2 Operational semantics - recap (optional)

If you have no prior knowledge about operational semantics, please familiarize yourself with the topic!
A first introduction can be found in this short video: `https://youtu.be/TU16mA5-i-g` For a detailed introduction, I recommend checking the slides by Xinyu Feng (`http://staff.ustc.edu.cn/~xyfeng/teaching/TOPL/lectureNotes/06_operational.pdf`) , the book *Models of Computation* by R. Bruni and U. Montanari (Chapter 1-3, available in the library), or the classical book *Types and Programming Languages (TAPL)* by Benjamin Pierce (unfortunately currently not available in the library).

3 Partial store ordering (PSO)

Partial store ordering (PSO) is a weak memory model similar to TSO but it does not guarantee that stores to *different* locations propagate to the main memory in the order they were issued. In particular, it allows the following weak behavior:

$$\begin{array}{r||l} x := 1; & a := y; \quad // 1 \\ y := 1 & b := x \quad // 0 \end{array}$$

1. Give the execution graph for the example. Using the axiomatic semantics, show why the execution is not sequentially consistent.
2. Provide operational semantics for the memory subsystem of PSO.
3. Extend the semantics with a *store-store fence*, whose placement between two stores ensures that the stores propagate to the main memory in their issue order.
4. (Optional) Prove that programs containing store-store fences between every two writes have the same outcomes under TSO and PSO.