

Exercise 4: Programming Distributed Systems (SS 2019)

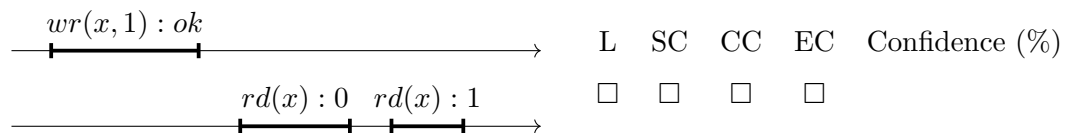
Prepare this sheet for the exercise on Wednesday, May 29th.

1 Consistency Models

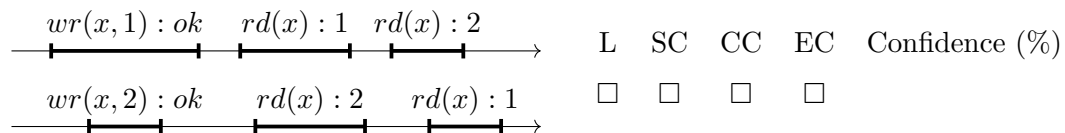
For the following executions, decide which of the consistency models Linearizability (L), SequentialConsistency (SC), CausalConsistency (CC), and BasicEventualConsistency (EC) would allow the execution. Multiple or no options might apply. Also state how confident you are in each answer by giving a value between 0% and 100%.

Each execution uses read (*rd*) and write (*wr*) operations on registers *x* and *y*. The initial value of registers is 0.

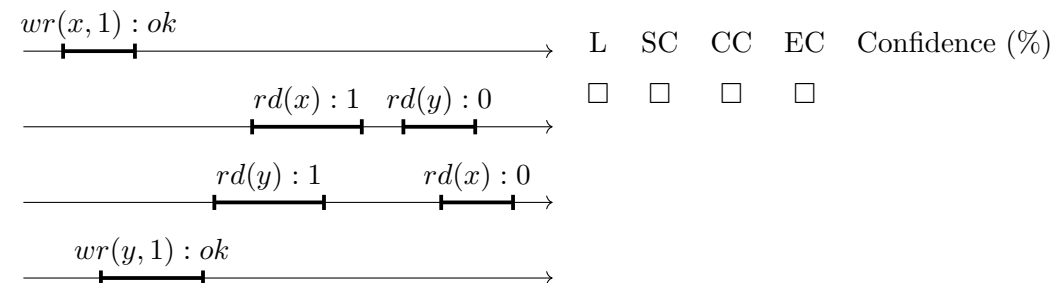
a)



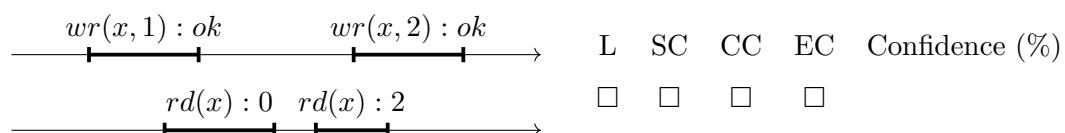
b)



c)



d)

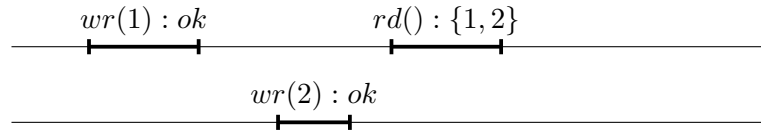


2 Concrete and abstract executions

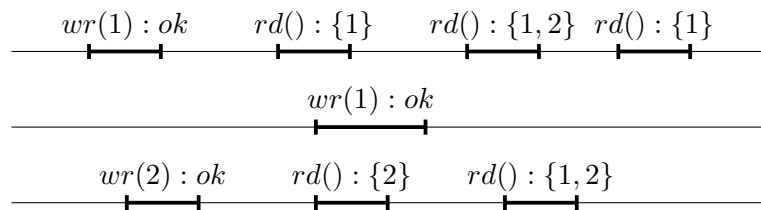
Consider the following concrete executions with operations on a Multi-Value Register object and provide an abstract execution that explains, why the execution is allowed under causal consistency.

Hint: To give an abstract execution, you need to specify the relation vis , which you can visualize in the pictures below by drawing arrows between operations.

a)



b)



3 CRDTs

Consider the Add-wins Set (Observed-remove Set, non-optimized version) presented in the lecture on CRDTs on slide 29. Prove that the downstream effect of an add-operation commutes with the effect of a concurrent remove-operation.

4 Registers

To better understand the differences between the registers discussed in the lecture, try to find example executions that show the differences:

- Give an execution that is not allowed for a safe register.
- Give an execution that is allowed for a safe register but not for a regular register.
- Give an execution that is allowed for a regular register but not for an atomic register.