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Exercises
Distributed Systemes: Part 2
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6. Exercise sheet: Distributed Concurrency Control and Replication

Exercise 1
Consider the following local schedules:

- $\begin{array}{lllllll} S_1: & R_1A & W_1A & R_2A & W_2A \\ S_2: & R_2B & W_2B & R_1B & W_1B \end{array}$
- $\begin{array}{lllllll} S_1: & R_1A & W_2A & & \\ S_2: & R_3B & W_1B & R_2C & W_3C \end{array}$
- $\begin{array}{lllllll} S_1: & R_1A & R_3A & R_3B & W_3A & W_3B & R_2B \\ S_2: & R_4D & W_4D & R_1D & R_2C & R_4C & W_4C \end{array}$
- $\begin{array}{llllllll} S_1: & W_1A & c_1 & R_3A & R_3B & c_3 & W_2B & c_2 \\ S_2: & W_2C & c_2 & R_4C & R_4D & c_4 & W_1D & c_1 \end{array}$

(1) Verify whether or not the schedules are serializable.

(2) Demonstrate that by applying Distributed 2PL/Timestamp Protocol prevents non-serializable schedules.

(3) Check whether or not the schedules are rigourous and commit-deferred.

(4) Demonstrate that by applying a Ticket-based concurrency control prevents non-serializable schedules.

Exercise 2
Keeping consistency in replicated data is a key issue, for which several approaches exist

a) Compare the combinations of update primary copy/update anywhere and eager/lazy propagation in terms of availability, consistency and cost for read/write operations

b) What kind of consistency problems could occur with a read quorum $\frac{2}{3}$N+1 and a write quorum of N/3+1?

Exercise 3
Eventual consistency provides high availability and scalability, but limits consistency

a) Provide examples of consistency problems/anomalies that could occur!

b) In current cloud storage systems, *Latest write wins* is a popular approach to resolve concurrent updates. Explain the problems that may occur when using physical/wall-clock timestamps!

c) Describe an approach that uses logical clocks to handle such concurrent updates

Exercise 4
Different consistency models provide different tradeoffs between availability and consistency

a) Explain why preventing lost updates can lead to unavailability

b) How can you guarantee Read Committed, but stay available?