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Exercises
Distributed Systemes: Part 2
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4. Exercise sheet: Refresh Concurrency Control and Recovery

Exercise 1
Consider the following schedules.

S_1: $R_3X\ R_2Y\ W_2Y\ R_1Y\ W_1Y\ R_2X\ W_2X\ R_1X\ W_1X\ W_3Z$.
S_2: $R_3X\ R_2Y\ W_2Y\ R_1Y\ W_1Y\ R_2X\ W_2X\ R_1X\ W_1X\ W_3Y$.
S_3: $R_1Y\ W_1Y\ R_2Y\ W_2Y\ R_2X\ W_2X\ R_3Z\ W_3X\ R_1X\ W_1X$.

For each schedule give its conflict graph. Which schedules are serializable, which are not?

Exercise 2
Assume on a database three transactions are being executed.

a) The transactions are of the form:
$T_1: \ RA \quad WA$
$T_2: \ RA \quad WA$
$T_3: \ RA \quad WA$

(i) How many serial schedules do exist for T_1, T_2, T_3? Give the reasons!

(ii) How many serializable schedules do exist for T_1, T_2, T_3, which are not serial ones? Give the reasons!

b) The transactions are of the form:
$T_1: \ RA \quad WC$
$T_2: \ RB \quad WA$
$T_3: \ RC \quad WD$

(i) How many schedules do exist for T_1, T_2, T_3, which are not serializable? Give the reasons!

(ii) Applying 2-phase-locking, is it possible that all serializable schedules of T_1, T_2, T_3 may occur? Give the reasons!

Exercise 3
Consider the schedule S:

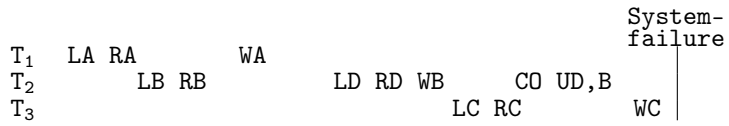
$T_1:$ $R(X)$ $W(Y)$
$T_2:$ $R(Y)$ $W(Y)$
$T_3:$ $R(Z)$ $W(Y)$

(a) Demonstrate that S is not (conflict-) serializable.
(b) We call two schedules equivalent, whenever (i) they are built out of the same transactions, (ii) in both schedules the transactions read the same values, and (iii) both schedules produce the same final state of the database. Demonstrate that the serial schedule $T_1\ T_3\ T_2$ and schedule S are equivalent.

Exercise 4
(a) Give an example of three transactions, which obey 2PL and have the following properties: (i) When being executed a deadlock may occur. (ii) For each pair of the three trnsactions and for any execution of such a pair, no deadlock can occur.
(b) Make suggestions for deadlock-free variants of the 2PL-protocol.

Exercise 5
Assume the granularity of objects used by a concurrency control are tuples and and the granularity of objects used by a recovery component are pages. Describe a scenario in which the restart algorithm will produce a state in the database which contradicts serializability of the corresponding transactions.

Exercise 6
Consider the following schedule.



Assume that actions W_1A, W_2B are not materialized in the database, however action W_3 is.

(i) Give the state of the database, the systembuffer and the log file when the system failure occurs.
(ii) Describe the operations done when executing the restart algorithm and give the resulting state of the database.