

Tutorial 8 — Transactions and Recovery

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March 19, 2018

Is the following transaction schedule *recoverable*?

Can we make a conflict-equivalent schedule that is *cascadeless*?

T1	r_x	r_y			c
T2		w_y		r_x	c
T3			w_x	r_x	c

In the context of recoverability, a transaction T **depends on** a transaction S if T reads a value that S has written to previously.

For a schedule to be recoverable, for any pair of transactions S and T, if T depends on S, then S must commit *before* T does.

In the given schedule, that means:

- T3 must commit before T2 does, and
- T2 must commit before T1 does.

Exercise 8-1 Solution (2/2)

For a schedule to be recoverable, for any pair of transactions S and T, if T depends on S, then S must commit *before* T reads a dependent value.

The following schedule is conflict-equivalent to the original, and is also cascadeless.

T1	r_x				r_y	c
T2		w_y			r_x	c
T3			w_x	r_x	c	

Note: In the case of an abort, only one transaction will need to roll back and the others can run; this does not preserve equivalence to the original schedule, but can still be consistent.

What is the weakest isolation guarantee available in SQL?

When would an developer want to use a weaker isolation level in their application?

The weakest isolation level provided by SQL is **read-uncommitted**.

This level guarantees *no dirty writes*: no writes on top of uncommitted writes by other transactions.

Weaker isolation affords a greater degree of concurrency, for a potential boost in throughput. Use if the possibly-resulting inconsistencies are irrelevant to the application, or they are otherwise worth dealing with.

Some DBMSes use snapshot isolation to implement *serializable*-level isolation. It works most of the time, but has failure cases.

How can snapshot isolation fail to create a serializable schedule, and what should happen when it creates a non-serializable schedule?

In **snapshot isolation**, transactions operate on a snapshot of the DB that looks as it did when the transaction started.

A consistency check (for dirty writes, essentially) is performed right before an attempted commit.

Snapshot isolation can result in non-serializable schedules because no additional work is done to ensure serializability as the schedule is generated. The consistency check at the end will abort non-serializable schedules.

Show that 2PL can create schedules that result in deadlock.

What can we do to **prevent** deadlock?

Exercise 8-4 Solution (1/2)

Recall that deadlock requires four conditions to be simultaneously true:

- 1 mutual exclusion,
- 2 hold-and-wait,
- 3 no pre-emption, and
- 4 circular wait.

A 2PL schedule that results in deadlock, supposing T1 wants to read resources a and b , and T2 wants to write to those same resources:

T1	s_a		s_b
T2		x_b	x_a

Note that in 2PL, transactions can run into deadlock only during their growing phase.

We can prevent deadlock by having a smarter lock manager. There are several ways to prevent deadlock. The following are some things that the lock manager can do:

- Use a deadlock detection algorithm (e.g. Banker's, graph algorithms) to determine whether granting a lock might lead to deadlock, and make the caller wait or abort if so. This can be expensive.
- Enforce a partial ordering (could be encoded with a tree) for lock acquisition to remove the possibility of circular wait.

Show that 2PL can create recoverable schedules with cascading rollbacks.

What variant of 2PL creates cascadeless schedules?

Exercise 8-5 Solution

T1	x_a	w_a	u_a										abort
T2				s_a	r_a	x_a	w_a	u_a					
T3										s_a	r_a	u_a	

Supposing that instead handling deadlock with an avoidance/prevention strategy, we try to detect and recover. How do we recover from a deadlock?

Recovering from a deadlock involves rolling back transactions until the circular wait is removed.

We choose a transaction to roll back using some heuristic that takes starvation into account, then roll back some or all of the transaction.