7. Exercise

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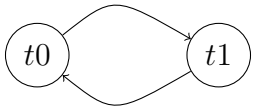
Exercise 7.1(Schedules, Serializability, and Locking)

7.1.1

The schedule is not conflict serializable, because its corresponding conflict graph is cyclic.
With the $conflict(s_0)$=$\{(w_0(A), r_1(A)), (r_1(B), w_0(B))\}$:



7.1.2

Using 2PL, we need to make sure that $wl_i(X) < wu_i(Y), i \in \{0, 1\}, X, Y \in \{A, B\}$.
So we got the following schedule s':

t_0	t_1
$wl_0(A)$	
$r_0(A)$	
$w_0(A)$	
	$wl_1(A) \rightarrow blocks$
$wl_0(B)$	
$r_0(B)$	
$w_0(B)$	
$wu_0(A)$	
$wu_0(B)$	
c_0	
	$wl_1(A) \rightarrow granted$
	$r_1(A)$
	$wl_1(B)$
	$r_1(B)$
	$wu_1(A)$
	$wu_1(B)$
	c_1

where the $DT(s') = r_0(A)w_0(A)r_0(B)w_0(B)c_0r_1(A)r_1(B)c_1$, and its conflict graph is acyclic with $conflict(DT(s')) = \{(w_0(A), r_1(A)), (w_0(B), r_1(B))\}$, so the schedule now is conflict serializable.:

7.1.3

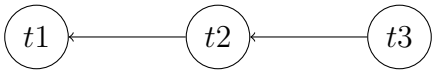
If we use locks without 2PL, we got the schedule s'':

t_0	t_1
$wl_0(A)$	
$r_0(A)$	
$w_0(A)$	
$wu_0(A)$	
	$wl_1(A)$
	$r_1(A)$
	$wu_1(A)$
	$wl_1(B)$
	$r_1(B)$
	$wu_1(B)$
	c_1
$wl_0(B)$	
$r_0(B)$	
$w_0(B)$	
$wu_0(B)$	
c_0	

where $DT(s'') = r_0(A)w_0(A)r_1(A)r_1(B)c_1r_0(B)w_0(B)c_0$, and its conflict graph is cyclic with $conflict(DT(s'')) = \{(w_0(A), r_1(A)), (r_1(B), w_0(B))\}$. So the lock leads to a not conflict serializable schedule.

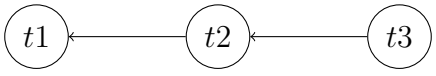
7.1.4

$s_1 = r_1(z)r_2(x)w_1(x)r_3(y)w_3(y)r_2(z)w_2(y)w_1(z)c_1c_2c_3$



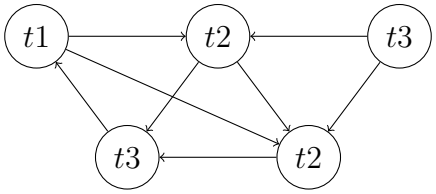
The conflict graph is acyclic, so $s_1 \in CSR$.
There is no non-overlapped transactions in s_1, so $s_1 \in OCSR$.
Commits in s_1 is $c_1c_2c_3$, not in the "conflict order" $t_3t_2t_1$, so $s_1 \notin CO$.

$s_2 = r_3(y)w_3(y)r_2(x)r_2(z)w_2(y)r_1(z)w_1(x)w_1(z)c_3c_2c_1$



The conflict graph is acyclic, so $s_2 \in CSR$.
Commits in s_2 is $c_3c_2c_1$, in the "conflict order" $t_3t_2t_1$, so $s_1 \in CO$, and also $s_1 \in OCSR$.

$s_3 = r_1(z)r_3(z)w_3(x)w_2(z)c_3r_4(x)w_4(z)c_2r_5(z)c_4w_5(y)w_1(y)c_1c_5$



The conflict graph contains cycles, so $s_3 \notin CSR$, as well as $s_3 \notin OCSR$, $s_3 \notin OC$.

$s_4 = r_1(z)r_3(z)w_3(x)w_2(z)r_4(x)c_2w_4(z)c_4r_5(z)c_3w_5(y)c_5w_1(y)c_1$
The order of actions except for commits in s_4 is same with this in s_3, so they have same conflict graph. Thus, $s_4 \notin CSR$, as well as $s_4 \notin OCSR$, $s_4 \notin OC$.

Exercise 7.2(Recovery)

7.2.1

7.2.2

7.2.3

Exercise 7.3(B+-tree Locking)

7.3.1

Search 52:
$rl(A)$
$rl(C)$
$ru(A)$
$rl(G)$
$ru(C)$
$r(G)$ ←read 52
$ru(G)$

7.3.2

Insert 19:
$wl(A)$
$wl(B)$
$wu(A)$ ← B is not full.
$wl(E)$
$wu(B)$ ←E is not full.

$w(E) \leftarrow$ insert 19
$wu(E)$

7.3.3

Delete 30:
$wl(A)$
$wl(C) \leftarrow$ half-empty
$wl(F) \leftarrow$ half-empty
$w(F) \leftarrow$delete 30
$redistribute(C, F, G) \leftarrow$ merge and redistribute
$delete(F)$
$redistribute(A, B, C) \leftarrow$update
$wu(A)$
$wu(C)$