

Data Bases II

Hierarchical Locking

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Exercise H.1

Consider the following schedule occurring on a system with hierarchical lock over a hierarchy where Pag_A contains tuples T_1 and T_2 :

$$r_1(\text{Pag}_A)w_2(T_1)w_1(T_2)$$

Show the sequence of lock, unlock, lock escalation, and lock downgrade requests for transactions t_1 and t_2 , taking into account that the schedule has to be 2PL.

Hint: t_1 should immediately acquire all locks.

	Pag_A	T_2	T_1	
$\text{SIXL}(\text{Pag}_A)$	SIXL_1			
$\text{XL}_1(T_2)$	SIXL_1	XL_1		
				$r_1(\text{Pag}_A)$
$\text{U-SL}_1(\text{Pag}_A)$	IXL_1	XL_1		lock downgrade
$\text{IXL}_2(\text{Pag}_A)$	$\text{IXL}_1, \text{IXL}_2$	XL_1		
$\text{XL}_2(T_1)$	$\text{IXL}_1, \text{IXL}_2$	XL_1	XL_2	
				$w_2(T_1)$
$\text{U-XL}_2(T_1)$	$\text{IXL}_1, \text{IXL}_2$	XL_1		
$\text{U-IXL}_2(\text{Pag}_A)$	IXL_1	XL_1		commit(t_2)
				$w_1(T_2)$
$\text{U-XL}_1(T_2)$	IXL_1			
$\text{U-IXL}_1(\text{Pag}_A)$				commit(t_1)

Exercise H.2

Given the schedule:

$$r_1(X)r_2(X)r_3(Y)w_3(Y)w_1(X)w_2(Y)$$

show the sequence of lock and unlock requests produced by the transactions in a 2PL execution, in a system providing the locks SL, UL and XL (where UL is the Update Lock).

NB: A convenient notation (to avoid ambiguity) could be

- $SL_i(X)$ to state that transaction T_i requires a shared lock on resource X
- $rel(SL_i(X))$ to state that the same lock is released

In such a system, in order to avoid deadlocks due to interleaved lock upgrades, any upgrade of the kind $SL \rightarrow XL$ is forbidden.

Instead, transactions that want to read first and then update a resource must acquire an UL first, and then upgrade it to XL ($UL \rightarrow XL$ is the only allowed upgrade).

Let's look at the schedule

$$r_1(X)r_2(X)r_3(Y)w_3(Y)w_1(X)w_2(Y)$$

Transactions 1 and 3 do have to use a UL, while transaction 2 operates on different resources.

Moreover, for the system to be 2PL compliant, transaction 2 must anticipate the acquisition of the lock on Y (w.r.t. $w_1(X)$), so that it can release its lock on X early enough.

These constraints can be satisfied, e.g., by the following sequence

	X	Y
$r_1(X)$	UL ₁	
$r_2(X)$	SL ₂	
$r_3(Y)$		UL ₃
$w_3(Y)$		XL ₃ (upgrade)
		rel(XL ₃)
		XL ₂
	rel(SL ₂)	
$w_1(X)$	XL ₁ (upgrade)	
	rel(XL ₁)	
$w_2(Y)$		rel(XL ₂)