Homework 5 | Transactions

Updates made to the assignment spec after release are highlighted in red.

Objectives: To evaluate the properties of transaction schedules, and to understand which of these properties are needed in which domain.

Due date: Friday, Nov 8th @ 11:00pm

***Median reported completion time (23sp, pre-restructuring):* 5 hours**

Problem Set

1. (15 points) Consider a database with 3 objects (also called “elements”): X, Y, and Z. Assume there are two transactions T_1 and T_2 that attempt the following operations:
   T_1: R(X), R(Y), W(X)
   T_2: R(X), R(Y), W(Y), R(X), R(Y), R(Z), W(X), W(Z)

   Create an example schedule for T_1 and T_2. This schedule must **interleave** the operations of T_1 and T_2, and it **must not be** conflict-serializable.

2. (15 points) Consider the same database, but T_1 has been simplified so it only consists of reads. Specifically, our new "transactions” consist of:
   T_1: R(X), R(Y)
   T_2: R(X), R(Y), W(Y), R(X), R(Y), R(Z), W(X), W(Z) *(same as before)*

   For each type of schedule below, list how many are possible from the above transactions and explain how you found your answer (no need to list them out).

   a. How many *serial* schedules are possible? How did you find this?
   b. How many *non-serial* schedules are possible? How did you find this?
   c. How many *conflict-serializable* schedules are possible? How did you find this?

3. (15 points) Consider the three schedules below. Here X and Y are database elements, while u, v, s, and t are local variables of the transactions. For each of the three schedules, indicate whether the schedule is serializable. Notice that the question is whether the schedule is *serializable*; the question is not whether the schedule is *conflict serializable*.

Schedule 1:

T1	T2
$R_1(X,u)$	
	$R_2(X,s)$
	$R_2(Y,t)$
	$W_2(X,\min(s,t))$
	$W_2(Y,\max(s,t))$
$R_1(Y,v)$	
$W_1(X,\min(u,v))$	
$W_1(Y,\max(u,v))$	

Schedule 2:

T1	T2
$R_1(X,u)$	
$R_1(Y,v)$	
	$R_2(X,s)$
	$R_2(Y,t)$
	$W_2(X,\min(s,t))$
	$W_2(Y,\max(s,t))$
$W_1(X,\min(u,v))$	
$W_1(Y,\max(u,v))$	

Schedule 3:

T1	T2
$R_1(X,u)$	
$R_1(Y,v)$	
$W_1(X,min(u,v))$	
	$R_2(X,s)$
	$R_2(Y,t)$
	$W_2(X,min(s,t))$
	$W_2(Y,max(s,t))$
$W_1(Y,max(u,v))$	

4. (15 points) Consider the following three transactions and schedule. Is this schedule conflict-serializable? Show why or why not, and include a precedence graph.

Line #	T_1	T_2	T_3
1	R(A)		
2	W(A)		
3			R(A)
4			W(A)
5		R(A)	
6	R(B)		
7			R(B)
8	W(B)		
9			W(B)
10		R(B)	
11		commit	
12	commit		
13			commit

5. (30 points) Now modify the above schedule by adding locks, which may block some transactions from doing their operations until the lock is released. You'll need to **rewrite** the above schedule in a table form. (The lecture slides show how to represent blocking in your schedules.)

   Use two-phase locking (doesn't need to be "strict") in your modified schedule to ensure a **non-serial** conflict-serializable schedule for the transactions above.

   Use the notation L(A) to indicate that the transaction acquires the lock on element A and U(A) to indicate that the transaction releases its lock on A.

6. (10 points) If 2PL ensures conflict-serializability, why do we need Strict 2PL? Explain briefly.

7. Reflection (OPTIONAL but really helps!)

   The remaining questions are completely optional, but help us understand if we are creating appropriately-challenging questions. You can choose to answer any subset of them.

   - How many hours did it take you to finish this assignment?
   - How many of those hours did you feel were valuable and/or contributed to your learning?
   - Is there anything you liked/disliked about this assignment?

   This is a restructured assignment, so we really appreciate your feedback!

Submission Instructions

You should submit the questions on Gradescope under HW5. We recommend uploading in PDF format. **Please tag each question to its corresponding pages** (you can ignore Q7 if you didn't do the reflection).