15-415: Database Applications
Problem Solving Assignment 5

School of Computer Science
Carnegie Mellon University, Qatar
Spring 2014

Assigned Date: April 17, 2014
Due Date: April 24, 2014 by 12 Midnight

I. Serializability and Locking Protocols [20 points]:

Consider Schedule ***A*** given below in **Table 1**. R(.) and W(.) denote 'Read' and 'Write', respectively. Ignore the lock T1:S(Y), for the moment.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
T1	S(Y)	R(Y)																		R(X)	
T2				W(X)																	
T3															R(X)		W(Z)				
T4									R(Z)		W(Y)										

Table 1: Schedule ***A*** with 4 transactions

a. Is schedule ***A*** serializable? Explain.

b. Is schedule ***A*** allowed by 2PL? If no, briefly explain why. If yes fill in **Table 1** with the lock/unlock requests that could have happened.
Notes:
   - Make sure that the 2PL protocol is obeyed.
   - Use the notations S(.), X(.), and U(.) to denote **S**hared lock, e**X**clusive lock, and **U**nlock, respectively.

c. Is schedule ***A*** allowed by *strict* 2PL? Explain.

II. Deadlock Detection [25 points]:

Consider the following two schedules, 1 and 2, shown in **Table 1** and **Table 2,** respectively.

	1	2	3	4
T1	S(A)			S(B)
T2		X(A)		
T3			X(B)	

Table 2: Schedule 1

	1	2	3	4	5
T4	S(D)				S(F)
T5		X(D)			
T6			X(F)	X(D)	

Table 3: Schedule 2

a. For schedule 1, assuming no other transactions exist, list which lock requests will be granted or blocked by the lock manager.

b. Give the wait-for graph for schedule 1.

c. For schedule 1, indicate whether or not there will be a deadlock at the end of the schedule. Explain briefly.

d. For schedule 2, assuming no other transactions exist, list which lock requests will be granted or blocked by the lock manager.

e. Give the wait-for graph for schedule 2.

f. For schedule 2, indicate whether or not there will be a deadlock at the end of the schedule. Explain briefly.

III. B+ Tree Locking [25 points]:

Consider the B+ tree in **Figure 2**. Use the non-conservative ***lock-coupling*** algorithm, Bayer-Schkolnick, to lock the B+ tree. The algorithm is described in lecture 21, as well as in page 561, Section 17.5.2 in the textbook.

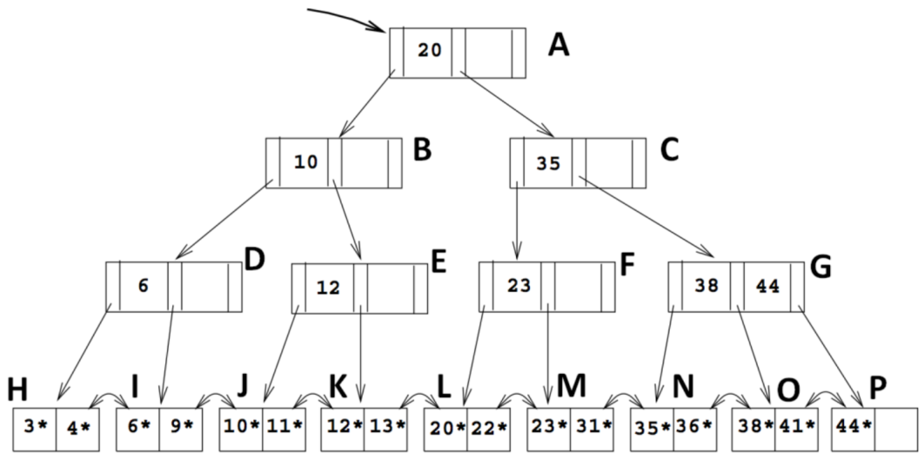

Figure 2: A sample B+ tree

For each of the following transactions give the sequence of lock/unlock requests. As in question 1, use S(.), X(.), and U(.) to denote **S**hared lock, e**X**clusive lock and **U**nlock, respectively.

a. **T1:** Search for the data entry 25*

b. **T2:** Insert the data entry 39*

c. **T4:** Insert the data entry 59*

d. **T5:** Delete the data entry 13*

IV. Recovery using ARIES [30 points]:

Consider the execution history shown in **Figure 3**. In addition, the system crashes during recovery after writing two log records to stable storage and again after writing another log record. Assume that we run the ARIES algorithm to recover from crashes. Answer the following questions:

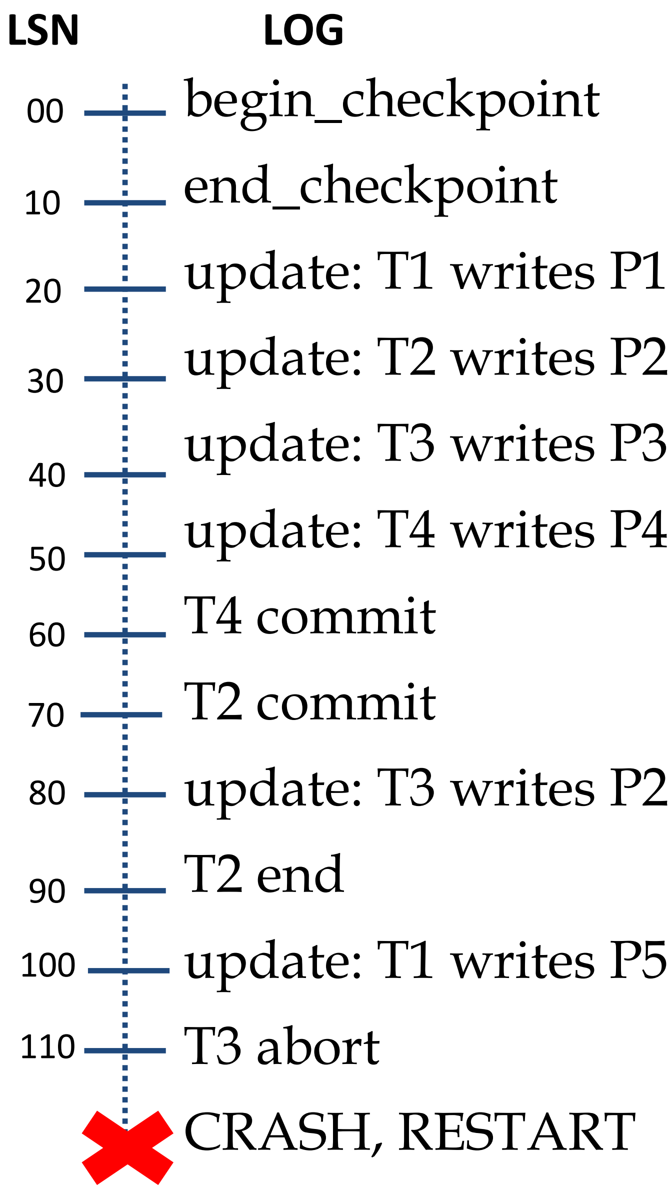

Figure 3: Execution with Multiple Crashes

a. What is done during the Analysis phase? In particular, show how the records in the Dirty Page and the Transaction tables are populated/altered/deleted during the Analysis phase.

b. What is done during the Redo phase? In particular, show how the ARIES algorithm proceeds with and finishes the Redo phase. Also, describe an execution that illustrates the use of the first condition in the Redo phase.

c. What is done during the Undo phase? In particular, show how the ARIES algorithm proceeds with and finishes the Undo phase.

d. Show the log when recovery is complete, including all non-null prevLSN and undoNextLSN values in log records.