Assignment 2

CS540- Advanced Database Management Systems

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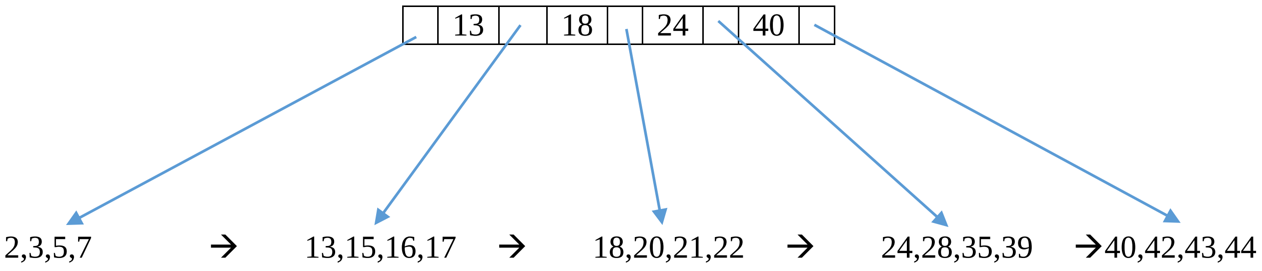
Question 1:

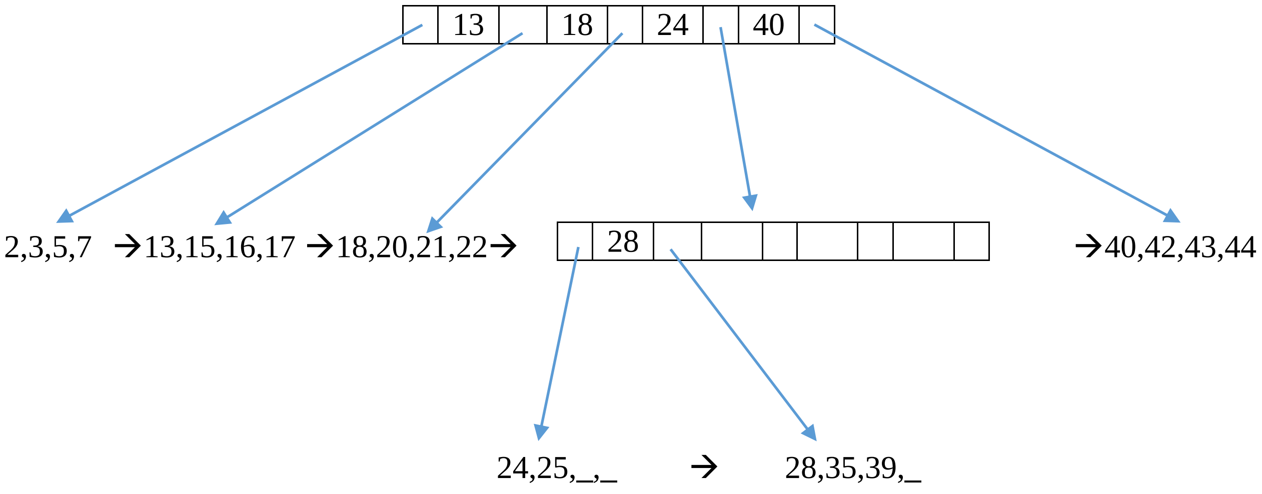
Using B+ trees with degrees of two (2) whose keys are integer values, give an example of a B+ tree whose height changes from 2 to 3 when the value 25 is inserted. Show your structure before and after the insertion. A B+ tree with a single node has height of 1.

Answer:

Before Inserting:



After Inserting 25:



Question 2:

Consider the join of the relation R and S on attributes R.a=S.b, given the following information about the relations to be joined. Relation R contains 10,000 tuples and has 10 tuples per block. Relation S contains 2000 tuples and also has 10 tuples per block. Attribute b of relation S is the primary key for S. Neither relation has any indexes built on it. 52 buffer pages are available in main memory. What is the cost of joining R and S using a sort-merge join? You should use a version of sort-merge algorithm that provides the minimum cost. The cost metric is the number of block I/Os.

Answer:
B(r) = 10,000/10 = 1000
B(s) = 2000/10 = 200
M = 52
Total cost = sorting + 2B(r)+2B(s) – B(r)
Sorting cost(r) = No. of passes*2*B(r)
Sorting cost(s) = No. of passes*2*B(s)
No. of passes = 1+ log [B(r)/M] to the base M-1
Sorting Cost(r) = 2*1000*ceil of [1+log20 to base 51]
= 2000*[1+1] = 4000
Sorting Cost(s) = 2*200*ceil of [1+log4 to base 51]
= 400*[1+1] = 800
Total cost = 2000+400+800+4000-1000
=6200

<u>Optimized</u>:

When B(r) + B(s) <= M^2

Total Cost = 3.B(r) + 3.B(s)

1000+200<= 52*52

1200 < 2704 → True

Total Cost = 3*1000 + 3 *200

= 3600 → Lowest I/O Cost

Question 3:

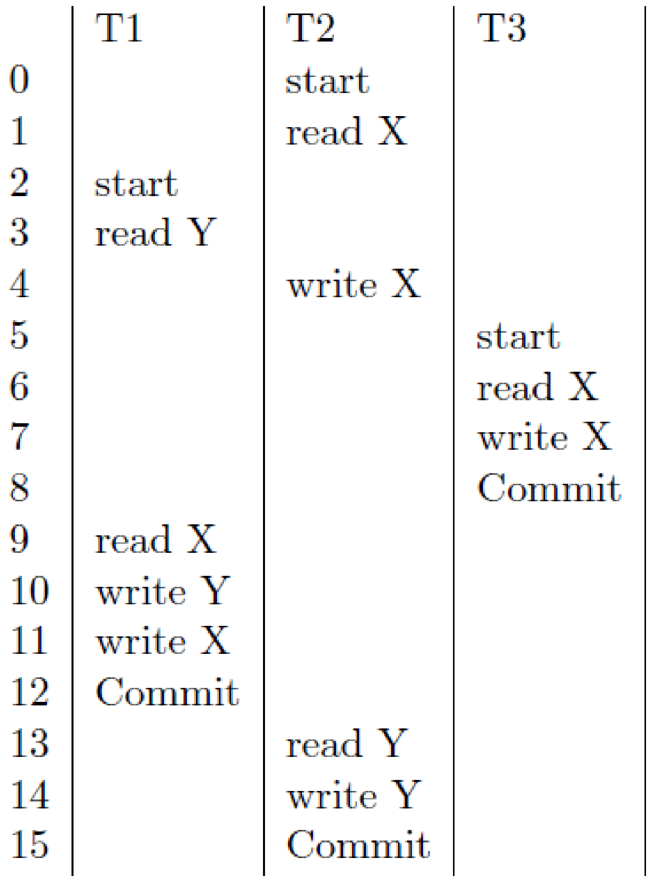
Consider the following relational schema and SQL query: Suppliers (sid, sname, city), Supply (sid, pid), Parts(pid, pname, price). SELECT S.sname, P.pname FROM Suppliers S, Parts P, Supply Y WHERE S.sid = Y.sid AND Y.pid = P.pid. How many different join orders, assuming that cross products are disallowed, does a System R style query optimizer consider when deciding how to process the given query? List the join orders.

Answer:

The only possible left deep join orders are:
1. (Suppliers X Supply) X Parts
2. (Supply X Parts) X Suppliers

Question 4:

Consider the schedule shown at Table 1.
(a) What is the equivalent serialization order for this schedule? If no order is possible, you may state so.
(b) When all transactions run in the above schedule, identify the transactions with degree 3 consistency. Answer the same question when transaction T3 does not exist in the schedule.

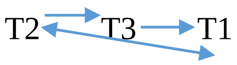


	T1	T2	T3
0		start	
1		read X	
2	start		
3	read Y		
4		write X	
5			start
6			read X
7			write X
8			Commit
9	read X		
10	write Y		
11	write X		
12	Commit		
13		read Y	
14		write Y	
15		Commit	

Table 1: Transaction schedule

Answer:

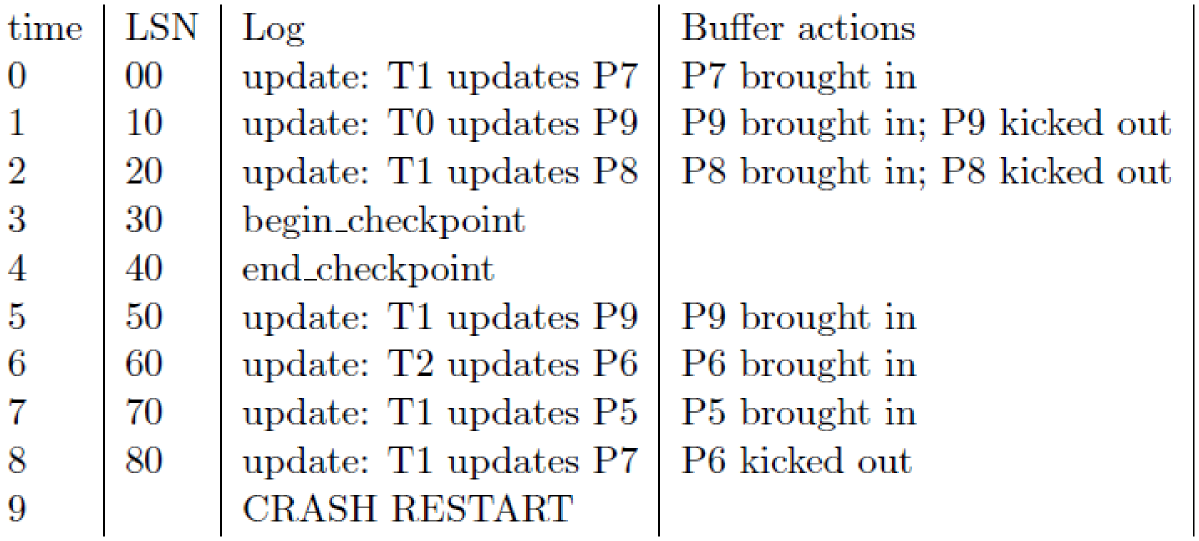
a. There is no Serialization schedule possible. Because there is a loop in the Serialization Graph from T1 to T2.



b. T2 can be of degree 3 consistency because If we apply locks on T2, T2 holds long shared read locks on X and long exclusive write locks on X which will prevent other transactions from dirty any data.

Question 5:

In this problem, you need to simulate the actions taken by ARIES. Consider the following log records and buffer actions:



time	LSN	Log	Buffer actions
0	00	update: T1 updates P7	P7 brought in
1	10	update: T0 updates P9	P9 brought in; P9 kicked out
2	20	update: T1 updates P8	P8 brought in; P8 kicked out
3	30	begin_checkpoint	
4	40	end_checkpoint	
5	50	update: T1 updates P9	P9 brought in
6	60	update: T2 updates P6	P6 brought in
7	70	update: T1 updates P5	P5 brought in
8	80	update: T1 updates P7	P6 kicked out
9		CRASH RESTART	

(a) For the actions listed above, show Transaction Table (XT) and Dirty Page Table (DPT) after each action. Assume that DPT holds pageID and recLSN, and XT contains transID and lastLSN.

(b) Simulate Analysis phase to reconstruct XT and DPT after crash. Identify the point where the Analysis phase starts scanning log records and show XT and DPT after each action.

(c) Simulate Redo phase: First identify where the Redo phase starts scanning the log records. Then, for each action identify whether it needs to be redone or not.

(d) Simulate Undo phase: identify all actions that need to be undone. In what order will they be undone?

Answer:

a.	**Transaction Table**		**Dirty Page Table**	
	Trans ID	**Last LSN**	**Page ID**	**rec LSN**
Step-0	T1	00	P7	00
Step-1	T1	00	P7	00
	T0	10	P9	10 Kicked Out
Step-2	T1	20	P7	00
	T0	10	P8	20 Kicked Out
Step-3	Start CheckPoint			
Step-4	End Checkpoint			
Step-5	T1	50	P7	00
	T0	10	P9	50
Step-6	T2	60	P6	60
	T1	50	P7	00
	T0	10	P9	50
Step-7	T1	70	P5	70
	T2	60	P6	60
	T0	10	P9	50
			P7	00
Step-8	T1	80	P5	70
	T2	60	P9	50
	T0	10	P7	00

b. Analysis Phase: We start from Last checkpoint and check which transactions committed/failed since checkpoint.

Step-3	Start CheckPoint			
Step-4	End Checkpoint---- Reconstruct the state at start check point			
	T1	20	P7	00
	T0	10		
Step-5	T1	50	P7	00
	T0	10	P9	50
Step-6	T2	60	P6	60
	T1	50	P7	00
	T0	10	P9	50
Step-7	T1	70	P5	70
	T2	60	P6	60
	T0	10	P9	50
			P7	00
Step-8	T1	80	P5	70
	T2	60	P9	50
	T0	10	P7	00

c. REDO Phase: Start from Smallest recLSN in Dirty Page Table

Transaction Table		Dirty Page Table	
T1	80	P5	70
T2	60	P9	50
T0	10	P7	00

Step-0	Redo	T1	00 because recLSN of P7 <= LSN
Step-1		T1	00
	No Redo	T0	10 because recLSN of P9 in DPT i.e. 50 > LSN i.e 10
Step-2	No Redo	T1	20 because P8 not in Dirty Page Table after Analysis
		T0	00
Step-3	Begin Checkpoint		
Step-4	End checkpoint		
Step-5	Redo	T1	50 because recLSN of P9 <= LSN
		T0	00
Step-6	No Redo	T2	60 because P6 not in Dirty Page Table after Analysis.
		T1	50
		T0	00
Step-7	Redo	T1	70 because recLSN of P5 <= LSN

		T0	00
Step-8	Redo	T1	80 because recLSN of P7<=LSN
		T0	00

d. UNDO Phase: Start from end, Undo all Transactions active during crash.

Step-8	Undo	T1	80 write CLR in Log
Step-7	Undo	T1	70 write CLR in Log
Step-6	Undo	T2	60 write CLR in Log, end T2
		T1	70
Step-5	Undo	T1	50 write CLR in Log
		T2	60
Step-4	End Checkpoint		
Step-3	Start Checkpoint		
Step-2	Undo	T1	20 write CLR in Log
		T2	60
Step-1	Undo	T0	10 write CLR in Log, end T0
		T1	20
		T2	60
Step-0	Undo	T1	00 write CLR in Log, end T1
		T0	10
		T2	60

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