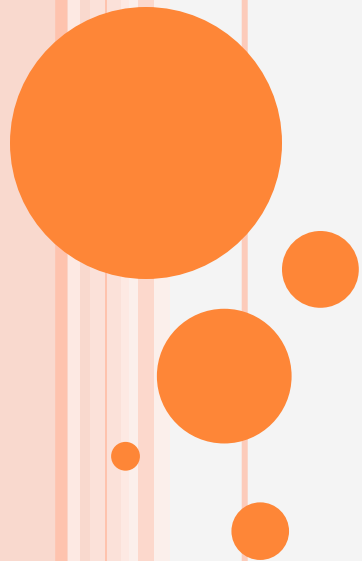


SERIALIZABILITY



SERIALIZABILITY

Serializable Schedule

A schedule is *serializable* if it is equivalent to a serial schedule



T1	T2
R(A)	
W(A)	
R(B)	
W(B)	
	R(A)
	W(A)
	R(B)
	W(B)
Serial Schedule	

T1	T2
R(A)	
W(A)	
	R(A)
	W(A)
R(B)	
W(B)	
	R(B)
	W(B)
Serializable Schedule A	

T1	T2
	R(A)
	W(A)
R(A)	
	R(B)
	W(B)
W(A)	
R(B)	
W(B)	
Serializable Schedule B	



NON-SERIALIZABLE SCHEDULES-

A non-serial schedule which is not serializable is called as a non-serializable schedule.

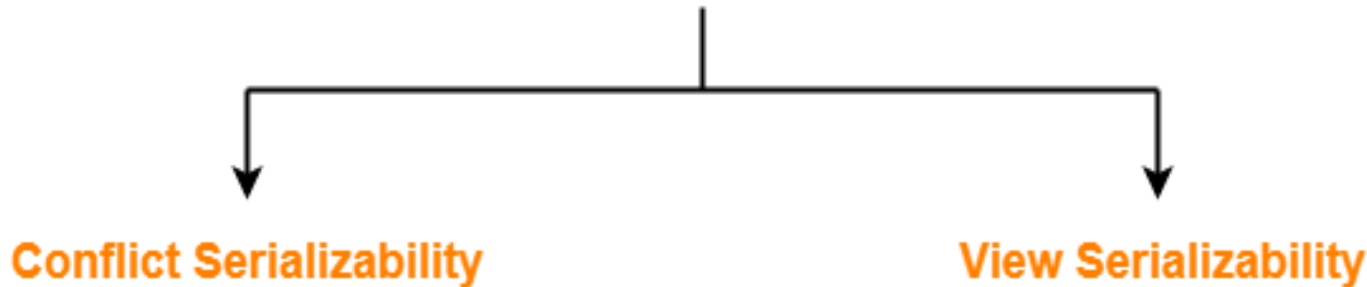
A non-serializable schedule is not guaranteed to produce the the same effect as produced by some serial schedule on any consistent database.

Characteristics-

- Non-serializable schedules-
- may or may not be consistent
- may or may not be recoverable



Types of Serializability



Conflict Serializability-

If a given non-serial schedule can be converted into a serial schedule by swapping its non-conflicting operations, then it is called as a **conflict serializable schedule**.



PRACTICE PROBLEMS BASED ON CONFLICT SERIALIZABILITY



Problem-:

Check whether the given schedule S is conflict serializable or not-

S : $R_1(A)$, $R_2(A)$, $R_1(B)$, $R_2(B)$, $R_3(B)$, $W_1(A)$, $W_2(B)$



SOLUTION:

Step1: List all the conflicting operations and determine the dependency between the transactions-

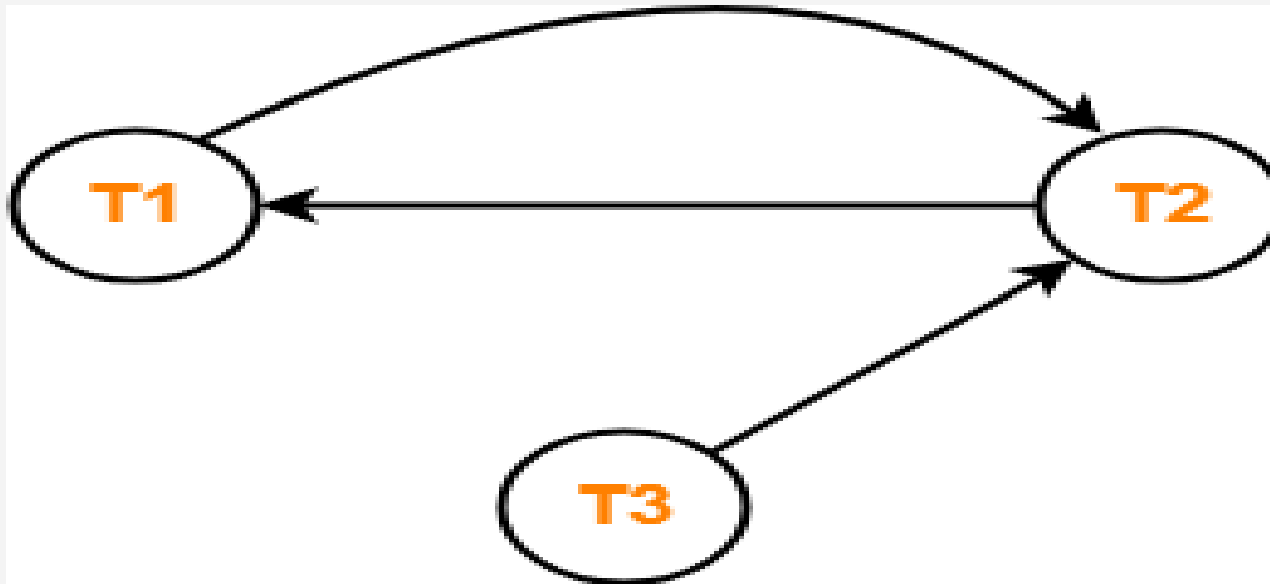
$R_2(A)$, $W_1(A)$ $(T_2 \rightarrow T_1)$

$R_1(B)$, $W_2(B)$ $(T_1 \rightarrow T_2)$

$R_3(B)$, $W_2(B)$ $(T_3 \rightarrow T_2)$



Step 2: Draw the precedence graph



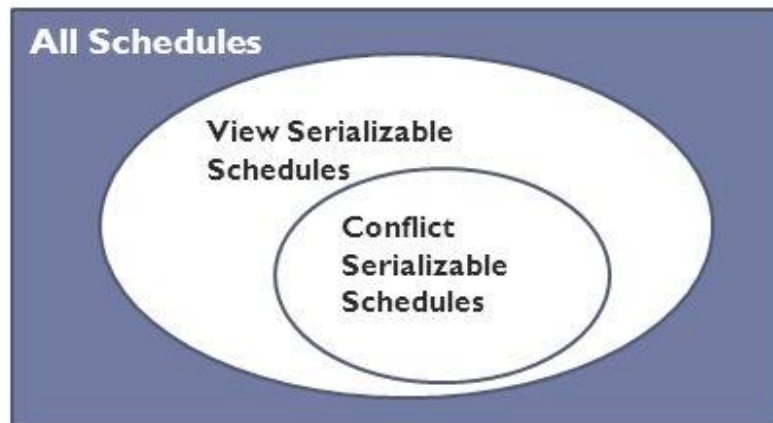
- Clearly, there exists a cycle in the precedence graph.
- Therefore, the given schedule S is not conflict serializable.



VIEW SERIALIZABILITY

- If a given schedule is found to be view equivalent to some serial schedule, then it is called as a view serializable schedule.

Every conflict serializable schedule is view serializable, although converse is not true.



It can be shown that any view serializable schedule that is not conflict serializable contains one or more **blind writes**.

VIEW SERIALIZABILITY



If a given schedule is found to be view equivalent to some serial schedule, then it is called as a view serializable schedule.

View Equivalent Schedules-

- Consider two schedules S1 and S2 each consisting of two transactions T1 and T2.
- Schedules S1 and S2 are called view equivalent if the following three conditions hold true for them-

VIEW SERIALIZABILITY

Condition-01:

For each data item X, if transaction T_i reads X from the database initially in schedule S1, then in schedule S2 also, T_i must perform the initial read of X from the database.

Thumb Rule

“Initial readers must be same for all the data items”.

Condition-02:

If transaction T_i reads a data item that has been updated by the transaction T_j in schedule S1, then in schedule S2 also, transaction T_i must read the same data item that has been updated by the transaction T_j .

Thumb Rule

“Write-read sequence must be same.”

Condition-03:

For each data item X, if X has been updated at last by transaction T_i in schedule S1, then in schedule S2 also, X must be updated at last by transaction T_i .

Thumb Rule

“Final writers must be same for all the data items”.

PRACTICE PROBLEMS BASED ON VIEW SERIALIZABILITY-

Check whether the given schedule S is view serializable or not-

T1	T2	T3	T4
R (A)	R (A)	R (A)	R (A)
W (B)	W (B)	W (B)	W (B)



PRACTICE PROBLEMS SOLUTION



- We know, if a schedule is conflict serializable, then it is surely view serializable.
- So, let us check whether the given schedule is conflict serializable or not.

Step-01:

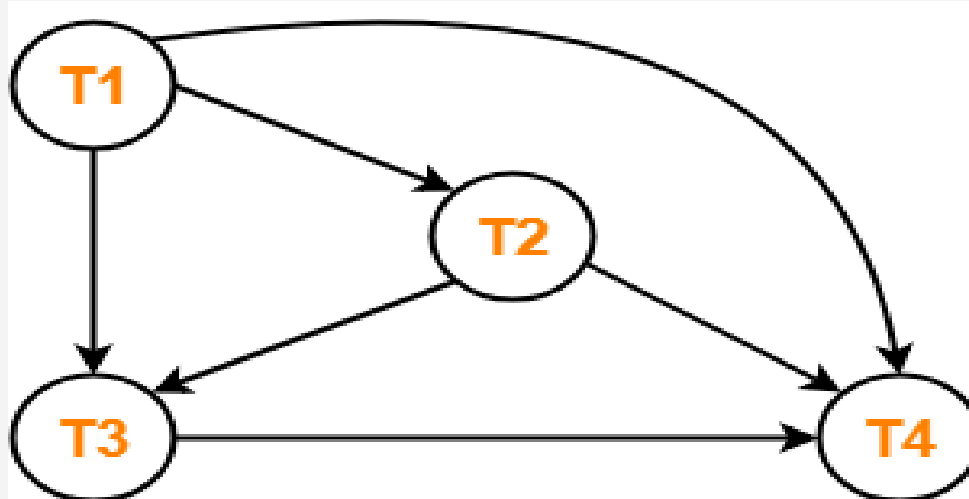
List all the conflicting operations and determine the dependency between the transactions-

- $W_1(B)$, $W_2(B)$ $(T_1 \rightarrow T_2)$
- $W_1(B)$, $W_3(B)$ $(T_1 \rightarrow T_3)$
- $W_1(B)$, $W_4(B)$ $(T_1 \rightarrow T_4)$
- $W_2(B)$, $W_3(B)$ $(T_2 \rightarrow T_3)$
- $W_2(B)$, $W_4(B)$ $(T_2 \rightarrow T_4)$
- $W_3(B)$, $W_4(B)$ $(T_3 \rightarrow T_4)$



PRACTICE PROBLEMS SOLUTION

Step-02: Draw the precedence graph-



- Clearly, there exists no cycle in the precedence graph.
- Therefore, the given schedule S is conflict serializable.
- Thus, we conclude that the given schedule is also view serializable.

PRACTICE PROBLEMS

Problem-: Consider schedule S1 :

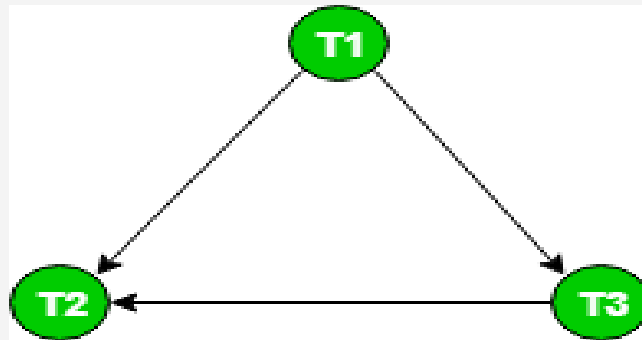
S1: r1(x) r3(y) w1(x) w2(y) r3(x) w2(x)

Is the given schedule is **CONFLICT
SERIALIZABILITY** ?



SOLUTION:

The graph for this schedule is :



Since the graph is acyclic, the schedule is conflict serializable.



PRACTICE PROBLEMS

Problem-: Consider the following schedules involving two transactions. Which one of the following statement is true?

S1: $R_1(X)$ $R_1(Y)$ $R_2(X)$ $R_2(Y)$ $W_2(Y)$ $W_1(X)$

S2: $R_1(X)$ $R_2(X)$ $R_2(Y)$ $W_2(Y)$ $R_1(Y)$ $W_1(X)$

- Both S1 and S2 are conflict serializable
- Only S1 is conflict serializable
- Only S2 is conflict serializable
- None



SOLUTION:

Let us first check serializability of S1:

S1: R1(X) R1(Y) R2(X) R2(Y) W2(Y) W1(X)

To convert it to a serial schedule, we have to swap non-conflicting operations so that S1 becomes equivalent to serial schedule T1->T2 or T2->T1.

In this case, to convert it to a serial schedule, we must have to swap R2(X) and W1(X) but they are conflicting. So S1 can't be converted to a serial schedule.



- Now, let us check serializability of S2:
- S2: R1(X) R2(X) R2(Y) W2(Y) R1(Y) W1(X)
- Swapping non conflicting operations R1(X) and R2(X) of S2, we get
- S2': R2(X) R1(X) R2(Y) W2(Y) R1(Y) W1(X)
- Again, swapping non conflicting operations R1(X) and R2(Y) of S2', we get
- S2'': R2(X) R2(Y) R1(X) W2(Y) R1(Y) W1(X)
- Again, swapping non conflicting operations R1(X) and W2(Y) of S2'', we get
- S2''': R2(X) R2(Y) W2(Y) R1(X) R1(Y) W1(X)
- which is equivalent to a serial schedule T2- \rightarrow T1.
- So, correct option is C. Only S2 is conflict serializable.

PRACTICE PROBLEM:

Consider the following transactions with data items P and Q initialized to zero:

T1: read (P) ;
 read (Q) ;
 if $P = 0$ then $Q := Q + 1$;
 write (Q) ;
T2: read (Q) ;
 read (P) ;
 if $Q = 0$ then $P := P + 1$;
 write (P) ;

Any non-serial interleaving of T1 and T2 for concurrent execution leads to

- (A) A serializable schedule
- (B) A schedule that is not conflict serializable
- (C) A conflict serializable schedule
- (D) A schedule for which a precedence graph cannot be drawn



PRACTICE PROBLEM SOLUTION:



○ Answer (B)

Two or more actions are said to be in conflict if:

- 1) The actions belong to different transactions.
- 2) At least one of the actions is a write operation.
- 3) The actions access the same object (read or write).

- The schedules S1 and S2 are said to be conflict-equivalent if the following conditions are satisfied:

- - 1) Both schedules S1 and S2 involve the same set of transactions (including ordering of actions within each transaction).

- - 2) The order of each pair of conflicting actions in S1 and S2 are the same.

THANKS!!

