

Computer Science & IT

Database Management System



Transaction & concurrency control

Lecture No. 03

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Recap of Previous Lecture



- ✓ Topic Durability
- ✓ Topic Isolation
- ✓ Topic Schedule (Serial schedule & Concurrent schedule)
- ✓ Topic Serializable schedule
- ✓ Topic Consistency

Topics to be Covered



Topic

Equivalent schedules

Topic

Serializable schedules



Q:- Consider two transactions.
 $T_1: R_1(A), W_1(A), R_1(B), W_1(B)$
 & $T_2: R_2(A), R_2(B)$

How many total schedules are possible over transactions T_1 & T_2

$${}^nC_r = {}^nC_{n-r}$$

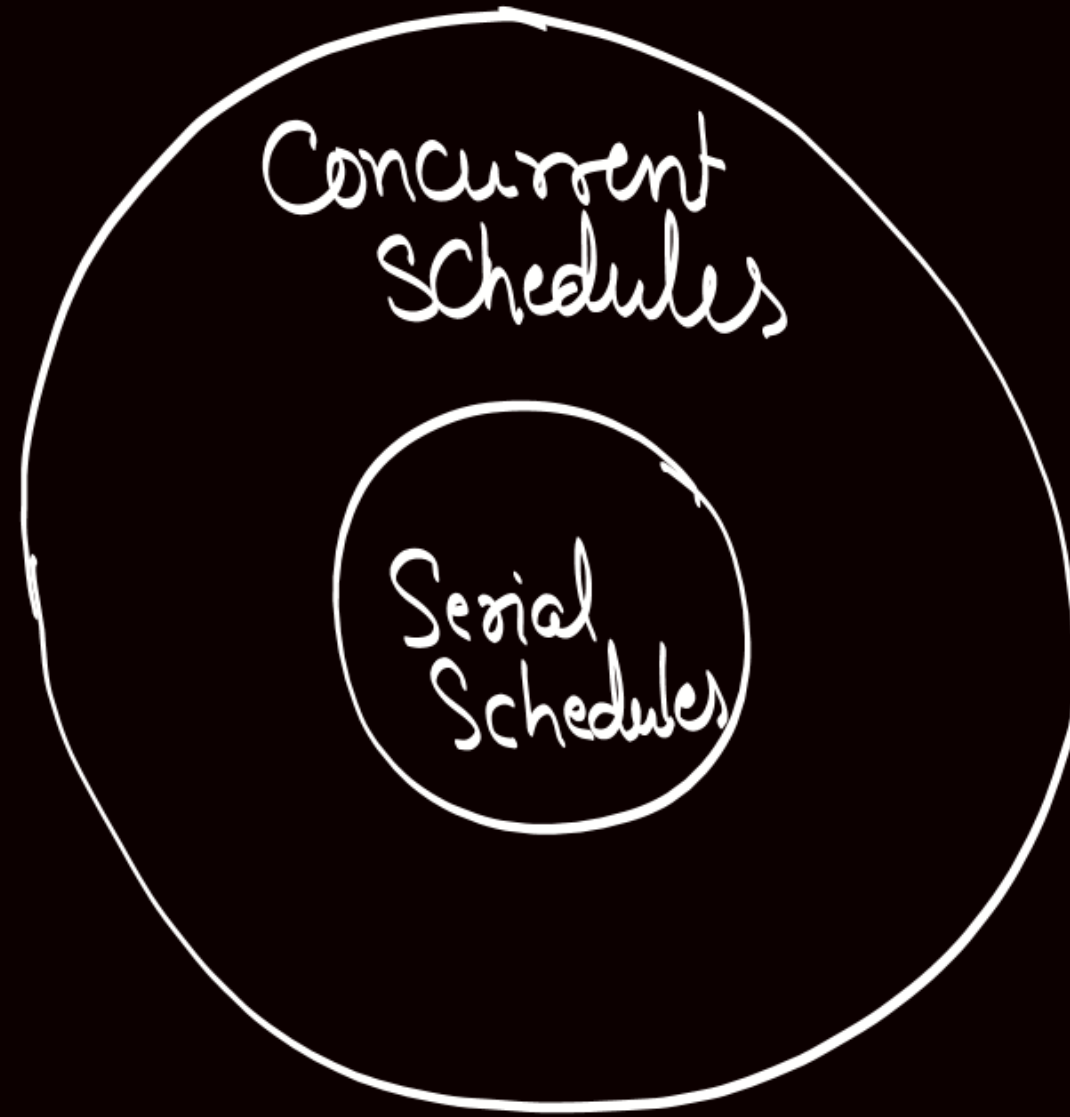
and

$$\begin{aligned} \text{Total no. of Schedules possible} &= ({}^6C_4 * 1) * ({}^2C_2 * 1) \\ &= {}^6C_4 = 15 \end{aligned}$$

$$\begin{aligned} &= ({}^6C_2 * 1) * ({}^4C_4 * 1) = {}^6C_2 = 15 \\ &= \frac{(4+2)!}{4! 2!} \end{aligned}$$

6 time slots for '6' opⁿ of T_1 & T_2

	T_1	T_2
1	→	
2		→
3	→	
4	→	
5		→
6	→	



} All serial schedules
are included in
all concurrent
schedules

Q:- Let T_1, T_2 , & T_3 are three transactions with m, n and p operations respectively.
How many Concurrent Schedules are possible over three transactions T_1, T_2 & T_3

$$\begin{aligned}
 \text{No. of Concurrent Schedules} &= \binom{m+n+p}{m} * 1 * \binom{n+p}{n} * 1 * \binom{p}{p} * 1 \\
 &= \binom{m+n+p}{m} * \binom{n+p}{n} * \binom{p}{p} \\
 &= \frac{(m+n+p)!}{m! n! p!}
 \end{aligned}$$

Q:- Let T_1, T_2 , & T_3 are three transactions with m, n and p operations respectively.

How many non-serial Concurrent schedules are possible over three transactions T_1, T_2 & T_3

$$\text{No. of non-serial Concurrent Schedules possible} = \left(\frac{(m+n+p)!}{m! n! p!} \right) - 3!$$

No. of serial Schedules w.r.t. '3' transactions

* Serializable Schedule \Rightarrow

A schedule is called a serializable schedule if and only if, behaviour of schedule is equivalent to at least one of the "serial schedule"



Topic : Equivalent schedule

For two schedules to be equivalent, following two conditions must be satisfied

① Every corresponding read operation must be same in both schedules.

and

② Final update (final write) for every corresponding dataitem must be same in both schedules.

Q. Consider two transactions,
 $T_1: R_1(A), W_1(A), R_1(B), W_1(B)$

$T_2: R_2(A), R_2(B)$

and following two schedules S_1 & S_2 over transactions T_1 & T_2

(S_1)

T_1	T_2
$R_1(A)$	
$W_1(A)$	
$R_1(B)$	
	$R_2(A)$
$W_1(B)$	
	$R_2(B)$

(S_2)

T_1	T_2
$R_1(A)$	
$W_1(A)$	
	$R_2(A)$
$R_1(B)$	
$W_1(B)$	
	$R_2(B)$

Check whether
 schedule S_1 & S_2
 are equivalent
 or not.

W.r.t. Read opⁿ:-

This reads are from initial database

(S₁)

T ₁	T ₂
R ₁ (A)	
W ₁ (A)	
R ₁ (B)	
W ₁ (B)	

R₂(A) of transaction T₂ is the value updated by T₁

R₂(B) of transaction T₂ is the value updated by T₁

This reads are from initial database

(S₂)

T ₁	T ₂
R ₁ (A)	
W ₁ (A)	
R ₁ (B)	
W ₁ (B)	

R₂(A) value updated by T₁

R₂(B) value updated by T₁

Note: All read opⁿ are exactly same in both the schedules

W.r.t. Final Write opⁿ

(S₁)

It is the final write of data-item 'A' in Schedule S₁

It is the final write of data-item 'B' in Schedule S₁

T ₁	T ₂
R ₁ (A)	
W ₁ (A)	
R ₁ (B)	
	R ₂ (A)
W ₁ (B)	
	R ₂ (B)

In schedule S₁
A is finally updated by transaction T₁

In schedule S₁
B is finally updated by transaction T₁

(S₂)

T ₁	T ₂
R ₁ (A)	
W ₁ (A)	
	R ₂ (A)
R ₁ (B)	
W ₁ (B)	
	R ₂ (B)

In schedule S₂
A is finally updated by T₁

In schedule S₂
B is finally updated by T₁

Note: In both the schedule final update of corresponding data items is also same

Q. Consider two transactions,
 $T_1: R_1(A), W_1(A), R_1(B), W_1(B)$
 $T_2: R_2(A), R_2(B)$
 and following two schedules S_1 & S_2 over transactions T_1 & T_2

(S_1)

T_1	T_2
$R_1(A)$	
$W_1(A)$	
$R_1(B)$	
	$R_2(A)$
$W_1(B)$	
	$R_2(B)$

(S_2)

T_1	T_2
$R_1(A)$	
$W_1(A)$	
	$R_2(A)$
$R_1(B)$	
$W_1(B)$	
	$R_2(B)$

Check whether Schedule S_1 & S_2 are equivalent or not

We observed

- ① Every corresponding read is identical in both the schedules S_1 & S_2
- ② Every final update of corresponding data item is also identical in both the schedules S_1 & S_2

→ ∴ S_1 & S_2 are equivalent

Q:- Check whether the schedule is a serializable schedule or not?

(S₃)

T ₁	T ₂
W ₁ (A)	R ₂ (A)
W ₁ (B)	R ₂ (B)

it is from initial database

Value updated by T₁

Serial schedules w.r.t. transactions of schedule S₃ are

T₁ → T₂

T ₁	T ₂
W ₁ (A)	
W ₁ (B)	
	R ₂ (A)
	R ₂ (B)

value updated by T₁
(Not same as S₃)

∴ S₃ ≠ T₁ → T₂

T₂ → T₁

T ₁	T ₂
	R ₂ (A)
	R ₂ (B)
W ₁ (A)	
W ₁ (B)	

from initial database
(Not same as S₃)

∴ S₃ ≠ T₂ → T₁

Schedule S₃ is not equivalent to any of the serial schedule
∴ Schedule S₃ is a non-serializable schedule

Q:- Check whether the schedule is a serializable schedule or not?

S_4

T_1	T_2
$R_1(A)$	
	$R_2(B)$
$R_1(C)$	
	$W_2(C)$

Serial Schedules
w.r.t. transactions
of schedule S_4

All read are
from initial
database

C is finally
updated by T_2

$T_1 \rightarrow T_2$

T_1	T_2
$R_1(A)$	
$R_1(C)$	

All read are from initial database
(Same as S_4)

$\therefore S_4 \equiv T_1 \rightarrow T_2$

C is finally
updated by T_2
(Same as S_4)

$T_2 \rightarrow T_1$

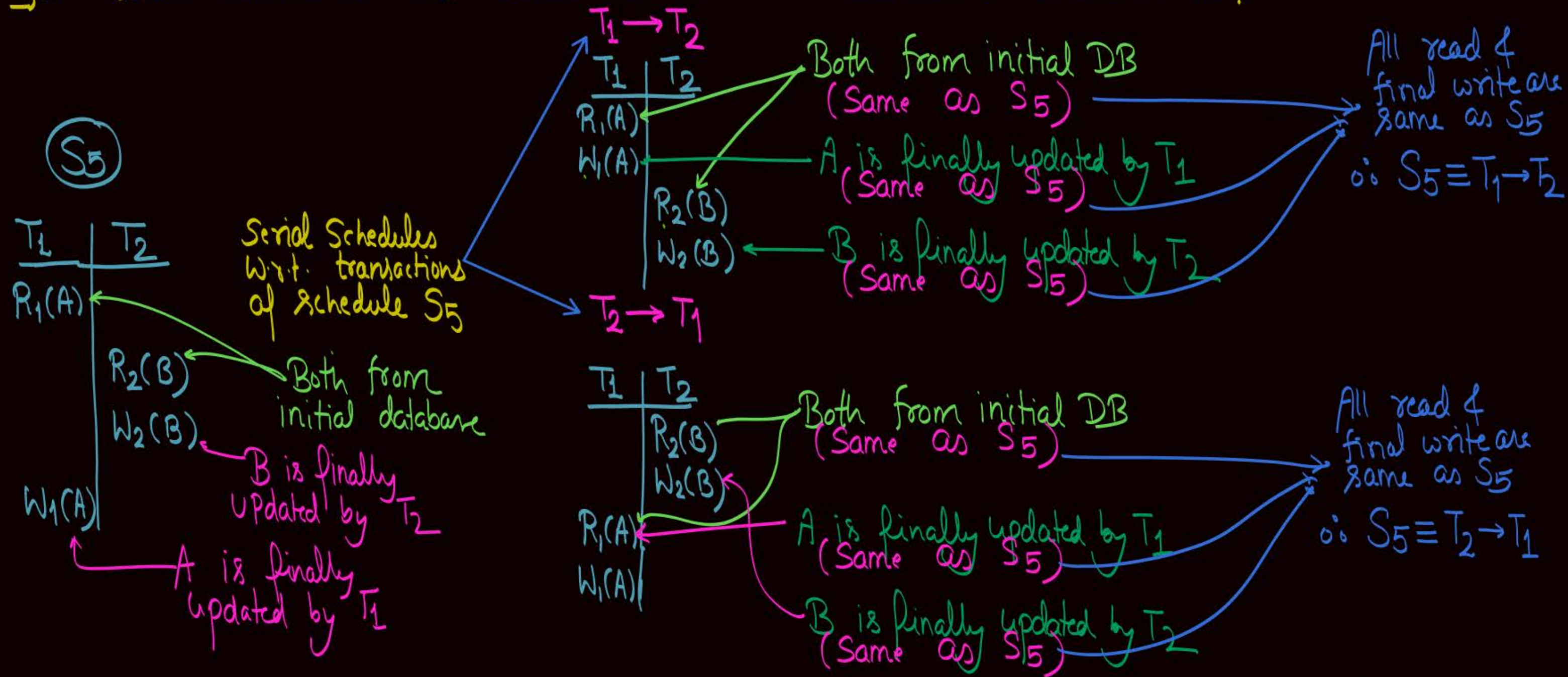
T_1	T_2
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	$R_2(B)$
	$W_2(C)$
$R_1(A)$	
$R_1(C)$	

value updated by T_2
(Not same as S_4) $\therefore S_4 \not\equiv T_2 \rightarrow T_1$

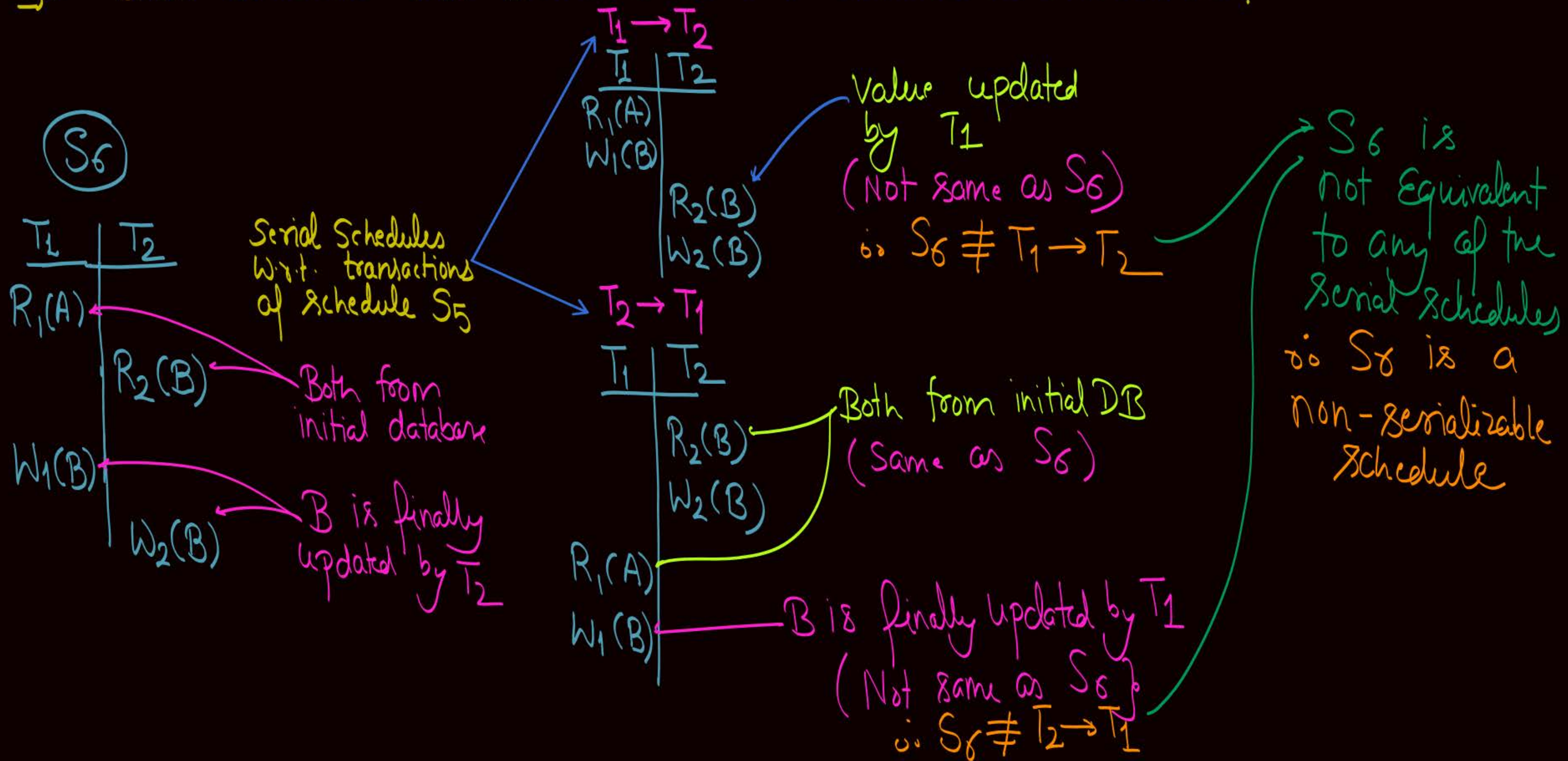
$S_4 \not\equiv T_2 \rightarrow T_1$, but $S_4 \equiv T_1 \rightarrow T_2$.
i.e. S_4 is Equivalent to at least
one Serial Schedule, Hence
 S_4 is a serializable schedule
and Equivalent Serial Schedule
is $T_1 \rightarrow T_2$

Q:- Check whether the schedule is a serializable schedule or not?



Schedule S5 is a serializable schedule, and two equivalent serial schedules, T₁ → T₂ & T₂ → T₁

Q:- Check whether the schedule is a serializable schedule or not?





2 mins Summary



Topic

Equivalent schedules

Topic

Serializable schedules

Read about :-

RW problem

WR problem

WW problem

Lost update problem

THANK - YOU