

Computer Science & IT

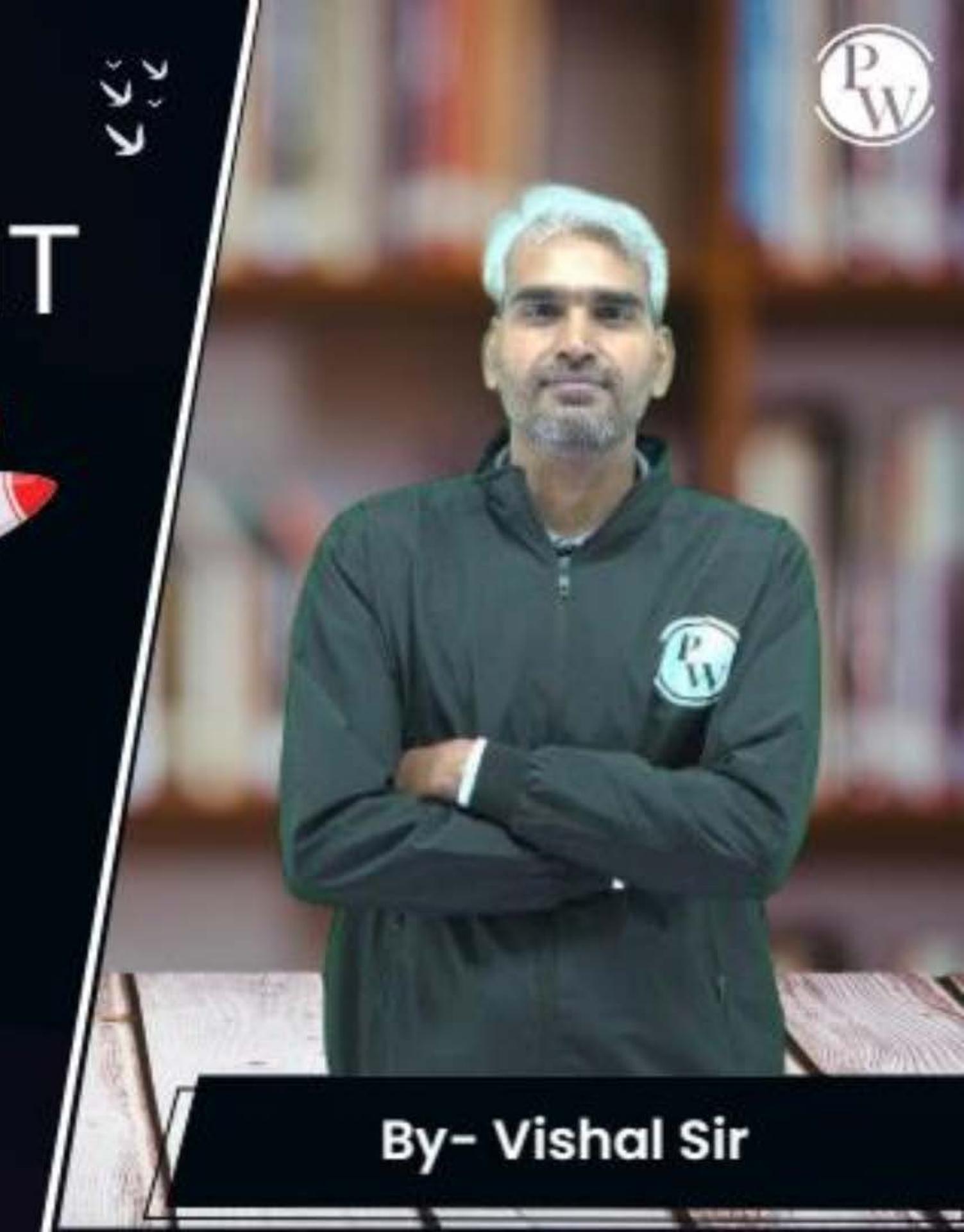
Database Management System



Transaction & concurrency control

Lecture No. 03

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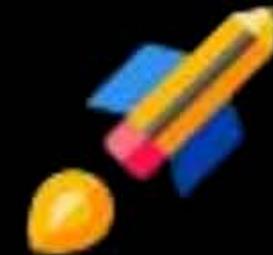
Recap of Previous Lecture



- 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.

T₁: R₁(A), W₁(A), R₁(B), W₁(B)

& T₂: R₂(A), R₂(B)

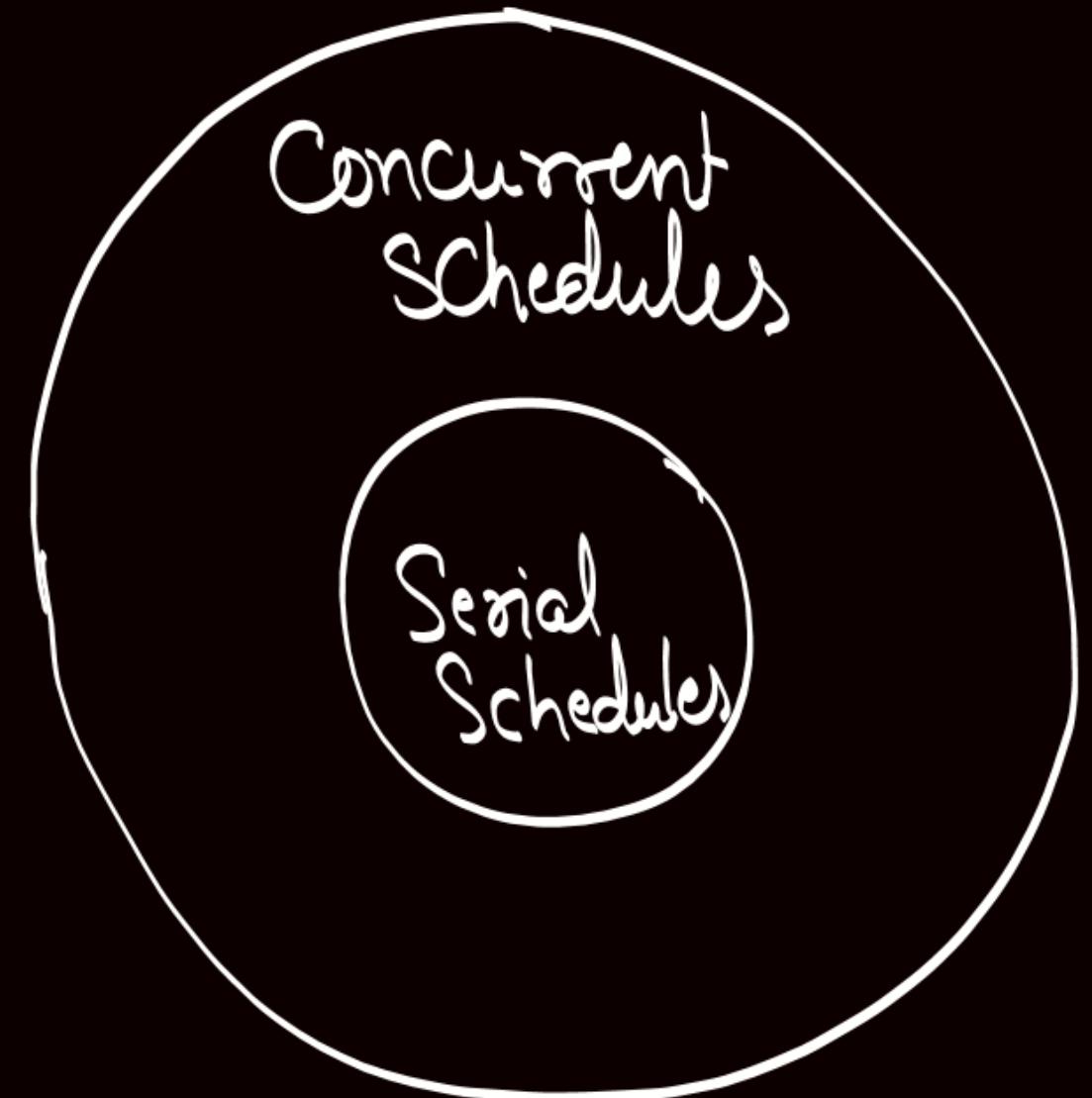
How many total schedules are possible over transactions T₁ & T₂

	T ₁	T ₂
6 time slots for 6 ops	*	
for T ₁ & T ₂	1	
	2	
	3	
	4	
	5	
	6	

Total no. of Schedules Possible = $\binom{6}{4} \times \binom{2}{2}$
= $6C_4 = 15$
= $\binom{6}{2} \times \binom{4}{4} = 15$
 $= \frac{(4+2)!}{4! 2!}$

$$n_C_r = n_C_{n-r}$$

and



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

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

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

No. of non-serial Concurrent schedules = $\frac{(m+n+p)!}{m! \ n! \ p!} - 3!$

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

* Serializable Schedule :→

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

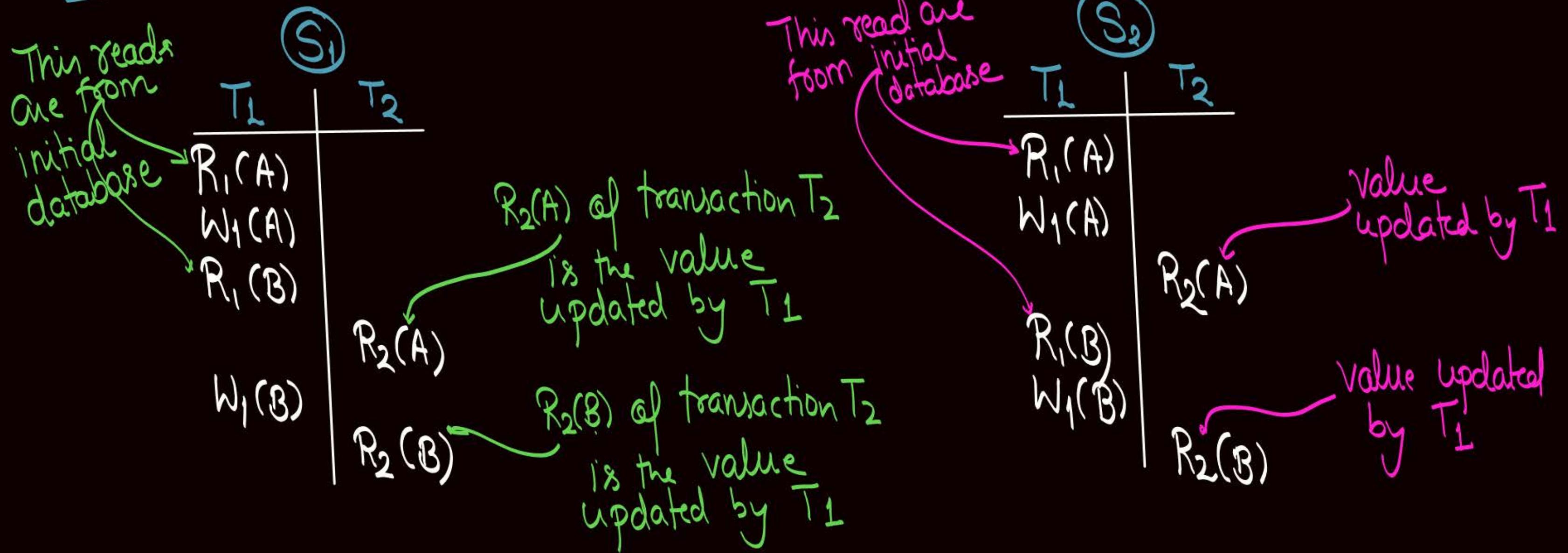
and following two schedules S_1 & S_2 over transactions T_1 & T_2

		S_1
		T_L
T_L	T_2	
$R_1(A)$		
$W_1(A)$		
$R_1(B)$		
	$R_2(A)$	
$W_1(B)$		
	$R_2(B)$	

		S_2
		T_L
T_L	T_2	
$R_1(A)$		
$W_1(A)$		
	$R_2(A)$	
$R_1(B)$		
$W_1(B)$		
	$R_2(B)$	

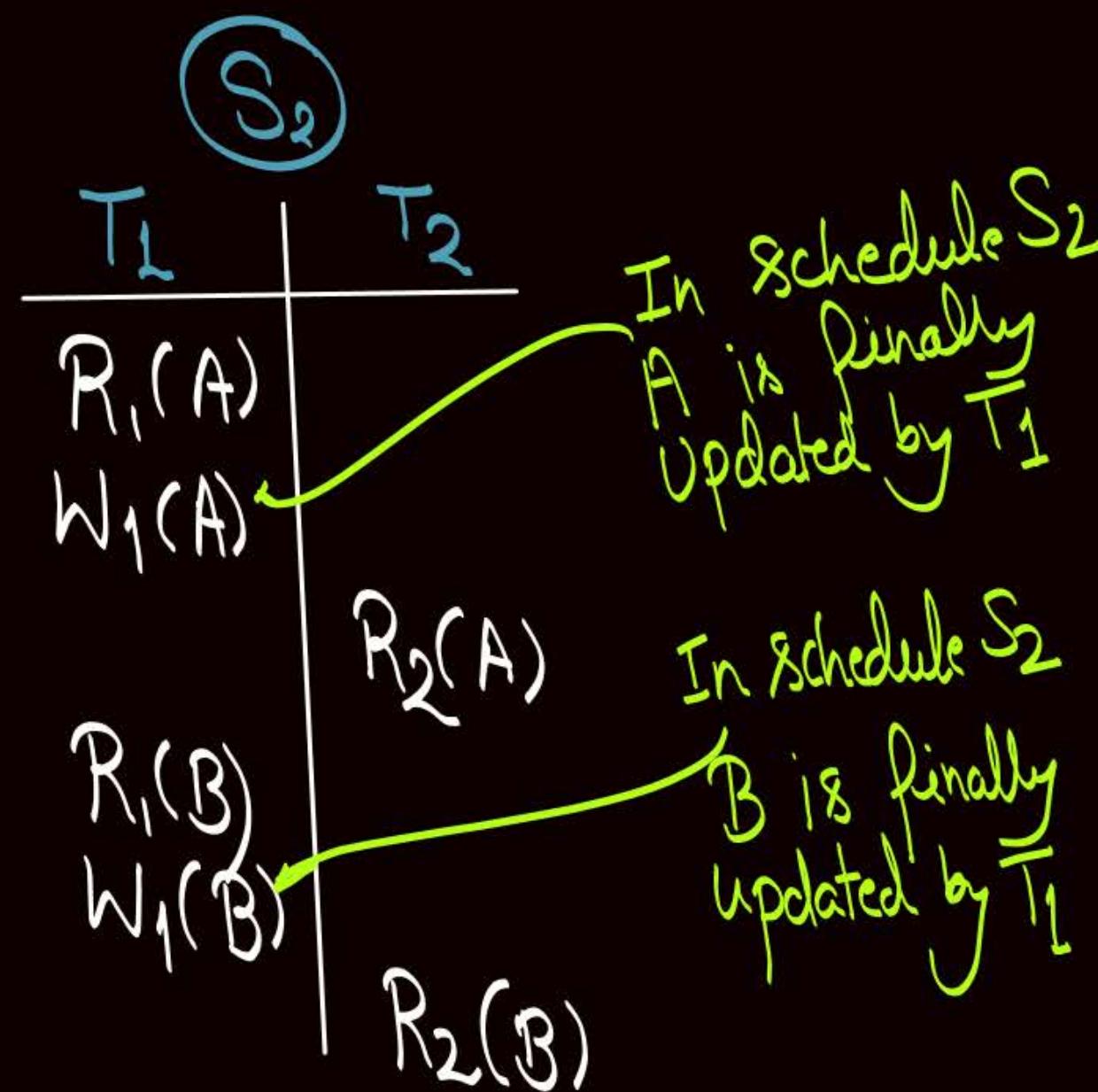
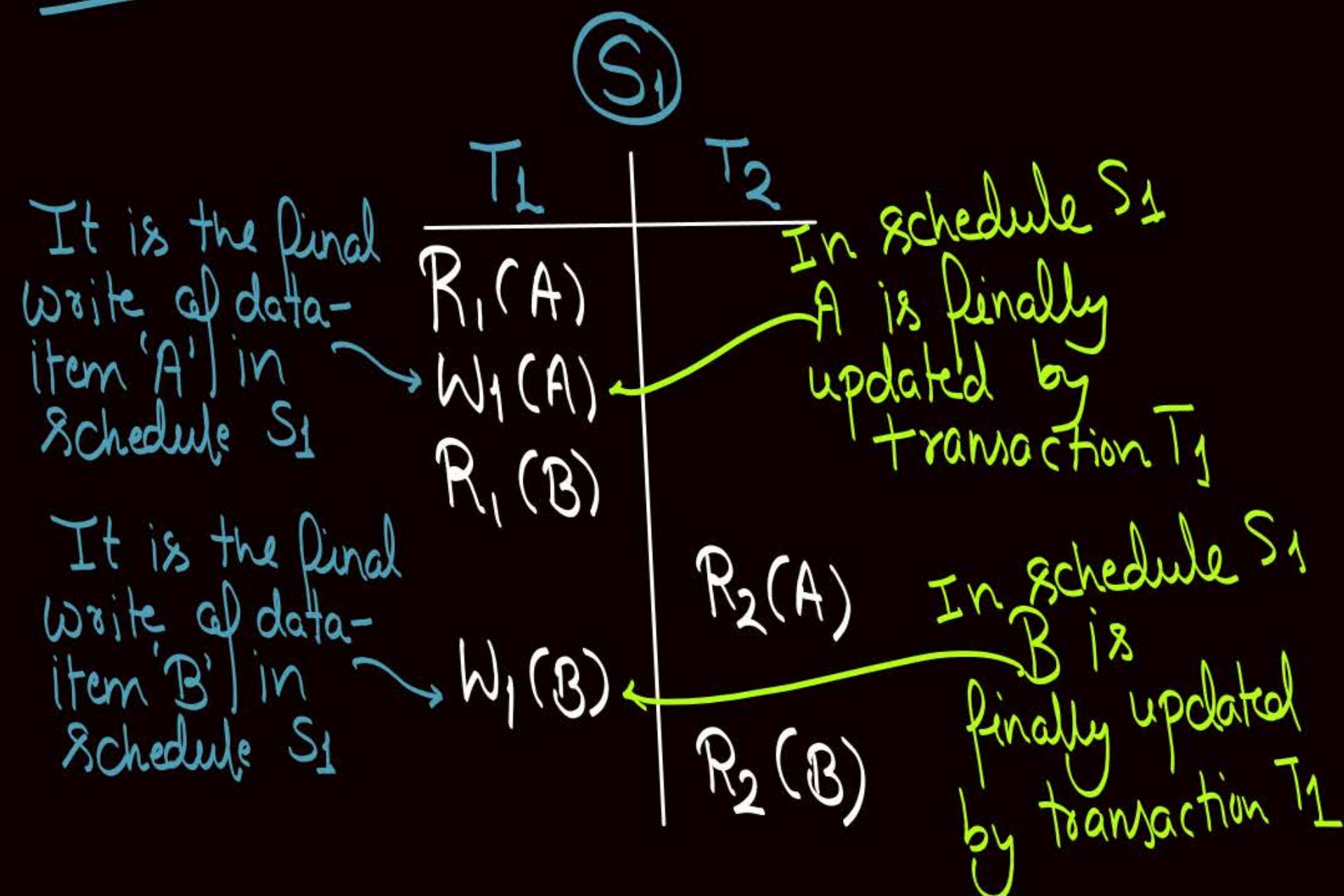
Check whether
schedule S_1 & S_2
are equivalent
or not.

W.r.t. Read opⁿ :-



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

W.r.t. Final Write Op'n



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

g. 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

S_1

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

S_2

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

two schedules S_1 & S_2 over transactions T_1 & T_2

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

\hookrightarrow so S_1 & S_2 are Equivalent

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

S ₃	
T ₁	T ₂
W ₁ (A)	R ₂ (A)
W ₁ (B)	R ₂ (B)

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

it is from initial database

Value updated by T₁

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

value updated by T₁
(Not same as S₃)
∴ S₃ $\not\equiv$ T₁ → T₂

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

from initial database
(Not same as S₃)
∴ S₃ $\not\equiv$ 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
$R_1(A)$	
$R_1(C)$	

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

$R_2(B)$	
$R_1(C)$	

All read are
from initial
database

C is finally
updated by T_2

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

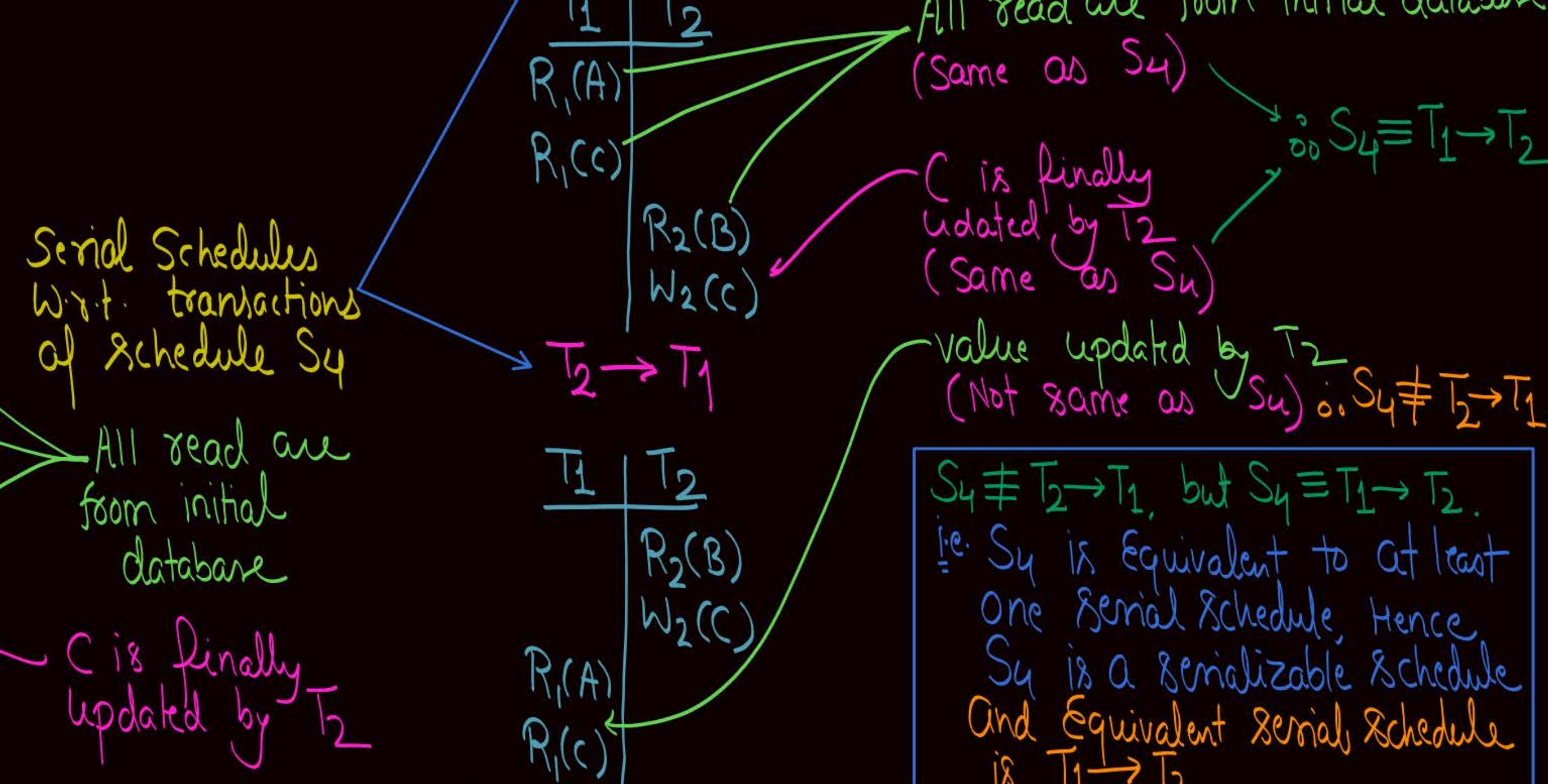
$T_2 \rightarrow T_1$

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

$T_1 \rightarrow T_2$

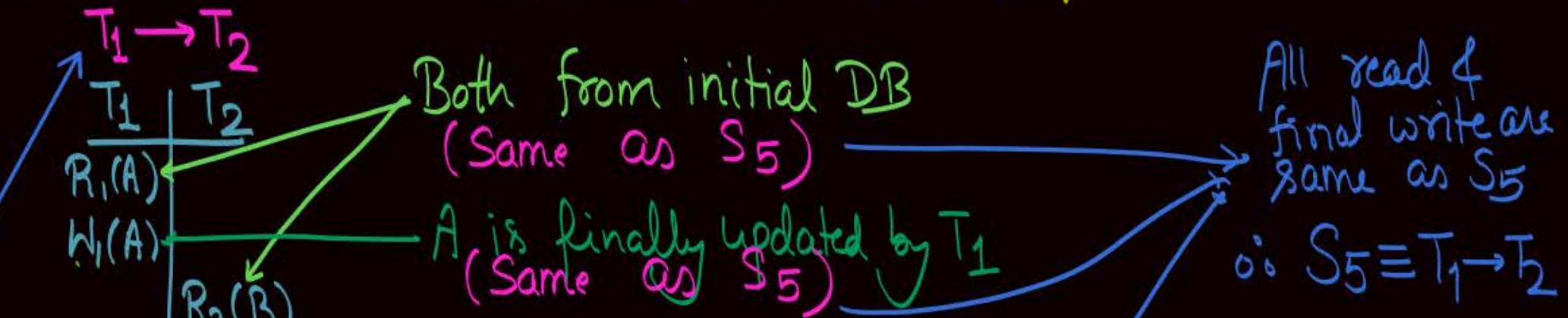
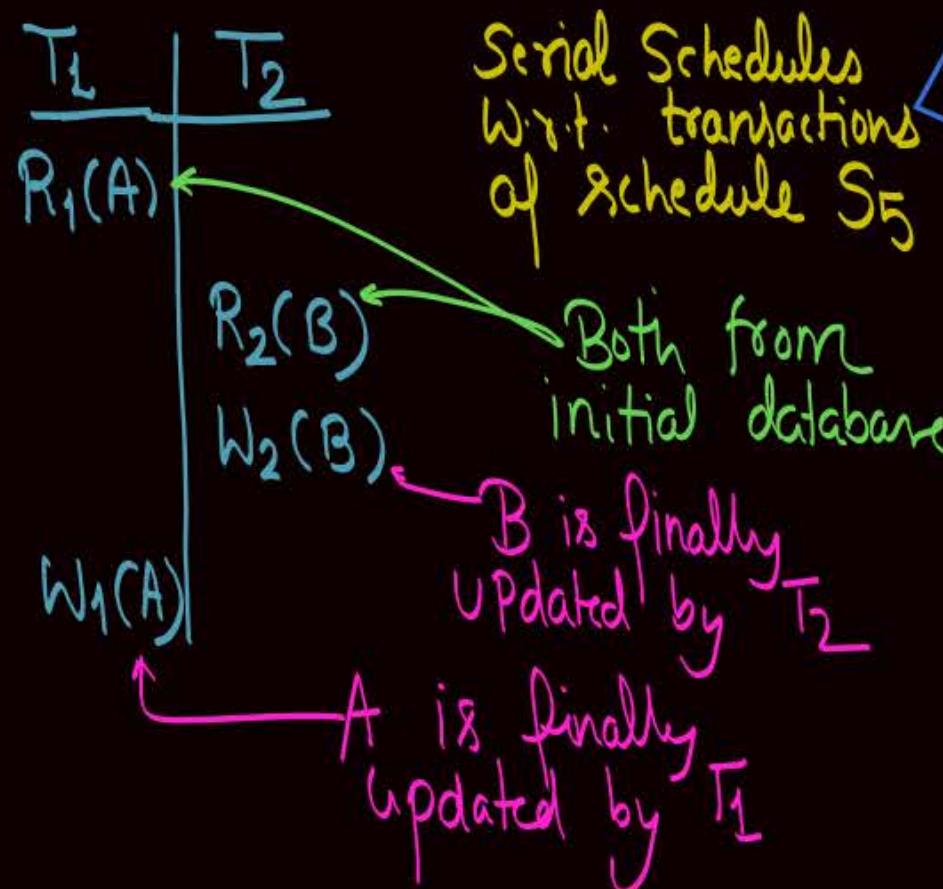
T_1	T_2
$R_1(A)$	
$R_1(C)$	

$T_2 \rightarrow T_1$



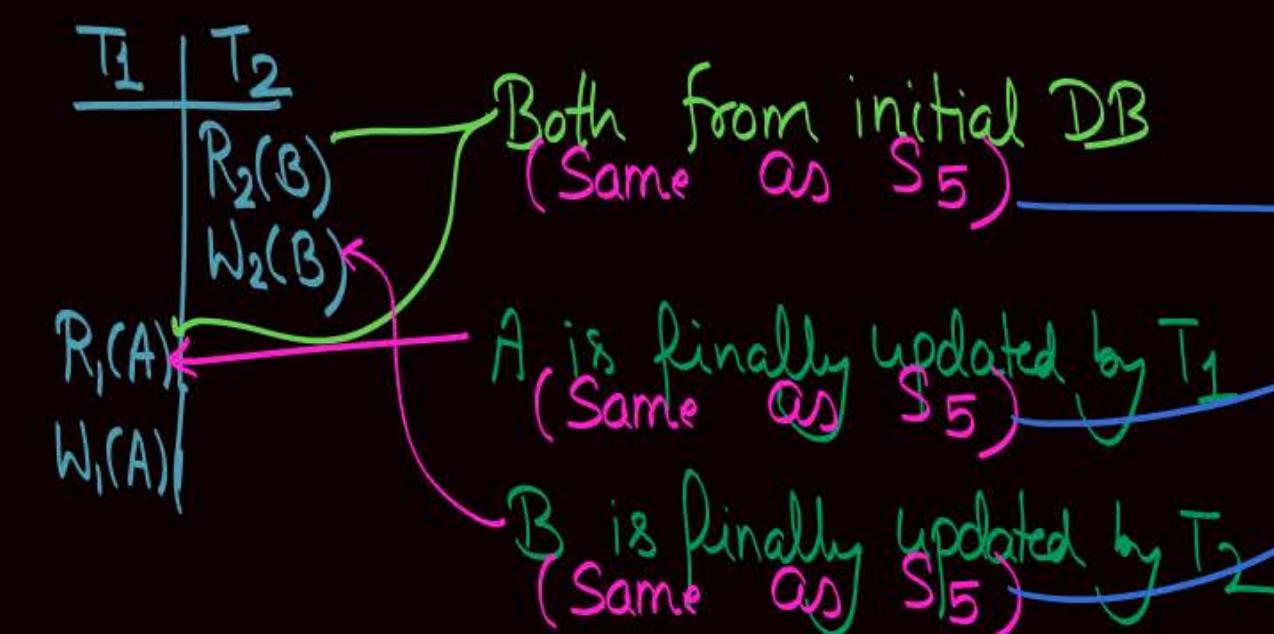
Q:- Check whether the schedule is a serializable schedule or not?

S_5



All read & final writes are same as S_5

$\therefore S_5 = T_1 \rightarrow T_2$



All read & final writes are same as S_5

$\therefore S_5 = T_2 \rightarrow T_1$

Schedule S_5 is a serializable schedule, and two equivalent serial schedules, $T_1 \rightarrow T_2$ & $T_2 \rightarrow T_1$

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

S_6

T_1	T_2
$R_1(A)$	

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

T_1	T_2
$W_1(B)$	
$W_2(B)$	

Serial Schedules
w.r.t. transactions
of schedule S_5

Both from
initial database

B is finally
updated by T_2

$T_1 \rightarrow T_2$	
T_1	T_2
$R_1(A)$	

$T_2 \rightarrow T_1$	
T_1	T_2
$R_2(B)$	

T_1	T_2
$R_2(B)$	

T_1	T_2
$W_2(B)$	

T_1	T_2
$R_1(A)$	

T_2	T_1
T_1	T_2
$R_2(B)$	

T_2	T_1
T_1	T_2
$W_2(B)$	

T_2	T_1
T_1	T_2
$R_1(A)$	

Value updated
by T_1

(Not same as S_6)

$\therefore S_6 \neq T_1 \rightarrow T_2$

S_6 is
not equivalent
to any of the
serial schedules

$\therefore S_6$ is a
non-serializable
schedule

Both from initial DB
(Same as S_6)

B is finally updated by T_1
(Not same as S_6)

$\therefore S_6 \neq T_2 \rightarrow T_1$



2 mins Summary



Topic

Equivalent schedules

Topic

Serializable schedules

- Read about :-
 - R W problem
 - W R problem
 - W W problem
 - Lost update problem

THANK - YOU