COMPUTER SCIENCE

Database Management System

Transaction & Concurrency Control

Lecture_9

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TOPICS TO BE COVERED

01 Conflict & View Serializable

02 Finding Conflict Serializable Schedule

Serializable

- Conflict Serializable
- View Serializable

Recoverablity

- Recoverable
- Cascadeless
- Strict Recoverable

Find Number of Conflict Serializable & View Serializable Schedule.

Data Item A

$R(A) - W(A)$

$W(A) - R(A)$

$W(A) - W(A)$

Q.1

Two transactions T_1 and T_2 are given as

T_1: $r_1(X)\ w_1(X)\ r_1(Y)\ w_1(Y)$

T_2: $r_2(Y)\ w_2(Y)\ r_2(Z)\ w_2(Z)$

Where $r_i(V)$ denotes a read operation by transaction T_i on a variable V and $w_i(V)$ denotes a write operation by transaction T_i on a variable V. The total number of conflict serializable schedules that can be formed by T_1 and T_2 is ______.

[NAT:2017–2M]

I $\quad T_1 \rightarrow T_2$

II $\quad T_2 \rightarrow T_1$

$T_1: \; r_1(X) \;\; w_1(X) \;\; r_1(y) \;\; w_1(y)$

$T_2: \; r_2(y) \;\; w_2(y) \;\; r_2(z) \;\; w_2(z)$

$T_1 \rightarrow T_2$

$T_2 \rightarrow T_1$

$\boxed{T_1 \rightarrow T_2}$

Start from last operation of T_1 Transaction

$w_1(y)$

$r_1(X) \; w_1(X) \; r_1(y) \; w_1(y)$

$w_1(y) \;|\; r_2(y) \; \xrightarrow{} \; w_1(y) \; \ldots \; w_2(y) \; \ldots \; r_2(z) \; \ldots \; w_2(z) \; \ldots$

$r_2(y) - w_1(y)$

Conflict operation

$T_2 \rightarrow T_1$

But Transaction order $T_1 \rightarrow T_2$.

So Not allowed.

$\boxed{T_1 \rightarrow T_2 \; : \; \mathrm{L}}$

T_1: $r_1(X)$ $w_1(X)$ $r_1(y)$ $w_1(y)$

T_2: $r_2(y)$ $w_2(y)$ $r_2(z)$ $w_2(z)$

$r_2(z)\, w_2(z)$ Can be Placed any where ($\because$ Different Data Item)

but after $w_2(y)$.

53 $\boxed{T_2 \rightarrow T_1}$

$r_2(z)\, w_2(z)$ Placed Any where.

$w_2(y)$

✓ $w_2(y)$ ↑ $r_1(X)$ $w_2(y)$ ↑ $w_1(X)$ $w_2(y)$ ↑ $r_1(y)$ ~~$w_2(y)$~~ ↑ $w_1(y)$ × ↑

$\boxed{\text{CASE III}}$ $\boxed{\text{CASE II}}$ $\boxed{\text{CASE I}}$

$r_1(y) - w_2(y)$ ⇓ Conflict operation $T_1 \rightarrow T_2$

But Transaction order $T_2 \rightarrow T_1$

CASE I	$r_1(X)$	$w_1(X)$	$\boxed{w_2(y)}$	$r_1(y)$	$w_1(y)$
CASE II	$r_1(X)$	$\boxed{w_2(y)}$	$w_1(X)$	$r_1(y)$	$w_1(y)$
CASE III	$\boxed{w_2(y)}$	$r_1(X)$	$w_1(X)$	$r_1(y)$	$w_1(y)$

$r_2(y)$ ① ✓   ② ✓ $r_2(y)$ ③ ✓ $r_2(y)$

$r_2(z)\ w_2(z)$ 3 Places

CASE I

.... $r_1(x)$ .... $w_1(x)$ .... $\boxed{w_2(y)}$ ... ① $r_1(y)$ ... ② $w_1(y)$ ... ③ ...

$r_2(y)$

$r_2(y) \longrightarrow 3 \times [3C_1 + 3C_2]$

$\Rightarrow 3 \times [3+3]$

$\boxed{\text{Case I} = 18}$

for $r_2(z)$ & $w_2(z)$ we have 3 Place (Position)

① Out of 3 Places Put them Together $[3C_1]$

OR

Out of 3 Places Put them separately $[3C_2]$

So $\boxed{3C_1 + 3C_2}$

CASE II: $r_2(y)$ ... $r_1(X)$ ... $\boxed{W_2(y)}$ ... ① $W_1(X)$ ... ② $r_1(y)$ ... ③ $W_1(y)$ ... ④

① $r_2(y)$ ② $r_2(y)$

$r_2(y) \neq 2$

$2 \times [4C_1 + 4C_2]$

$2 \times [4 + 6]$

$\boxed{\text{Case II : 20 ways.}}$

CASE III $r_2(y)$ $\boxed{W_2(y)}$ ① $r_1(X)$ ② $W_1(X)$ ③ $r_1(y)$ ④ $W_1(y)$ ⑤

$1 \times [5C_1 + 5C_2]$

$\boxed{\text{CASE III : 15}}$

$T_2 \rightarrow T_1$

CASE I : 18
CASE II : 20
CASE III : 15

53

Total Number of Conflict serializable :

$T_1 \rightarrow T_2$: 1
$T_2 \rightarrow T_1$: 53

54 Ans

$T_1 \rightarrow T_2$, $T_2 \rightarrow T_1$

$T_1 \rightarrow T_2$

$T_2 \rightarrow T_1$

Note

1. Write Down All the operation of the following (Later) Transaction

2. Start last operation of the first Transaction & put that operation at Correct Place Such that Conflict operation order Must be Same as Transaction order.

Q.2

Consider the transaction T_1 and T_2 given below: **[NAT]**

T_1 : $R_1(A)$ $R_1(B)$ $W_1(B)$

T_2 : $R_2(A)$ $R_2(B)$ $W_2(B)$

Where $R_i(A)$ denote a read operation by transaction T_i on a Data Item (A) W_i (B) Denote a write operation by transaction T_i on a Data Item B.

The Total number of conflict serializable schedule is____.

$T_1 \rightarrow T_2$

$T_2 \rightarrow T_1$

T_1: $R_1(A)$ $R_1(B)$ $W_1(B)$

T_2: $R_2(A)$ $R_2(B)$ $W_2(B)$

$R_2(B) - W_1(B)$

$T_2 \to T_1$

But order is $T_1 \to T_2$

$\boxed{T_1 \to T_2}$

Last operation of first Transaction (T_1)

$W_1(B)$

$W_1(B)$ ✓ (CASE II) $R_2(A)$ $W_1(B)$ (CASE I) $R_2(B)$ $W_1(B)$ ✗ $W_2(B)$

CASE I: $R_2(A)$ $\boxed{W_1(B)}$ $R_2(B)$ $W_2(B)$

CASE II: $\boxed{W_1(B)}$ $R_2(A)$ $R_2(B)$ $W_2(B)$

$R_1(A)\ R_1(B)$

CASE I

$R_1(A)\ R_1(B)$

$R_1(A)\ R_1(B)$ ② $R_2(A)$ ① $\boxed{W_1(B)}$ $R_2(B)$ $W_2(B)$

$$2C_1 + 2C_2 \Rightarrow 2+1 = 3$$

$R_1(A)\ R_1(B)$
Out of 2 place

Put them together $2C_1$ place
or
separately $2C_2$

$\boxed{2C_1 + 2C_2}$

CASE II

$R_1(A)\ R_1(B)$ —— $\boxed{W_1(B)}$ $R_2(A)$ $R_2(B)$ $W_2(B)$

1 ways

$T_1 \rightarrow T_2 = 3+1 = 4$

$T_2 \rightarrow T_1 = 3+1 = 4$ (B/c exact same operation & same operation order)

Total Conflict Serializable $= 8$

Note

Total serial Schedule $= 2$

Non Serial Conflict Serializable $= 8-2$

$= 6$ Ans

Q.3

Consider the transaction T_1 and T_2 given below: [NAT]

T_1 : $R_1(A)$ $R_1(B)$ $W_1(B)$

T_2 : $R_2(B)$ $R_2(A)$ $W_2(B)$

Where $R_i(A)$ denote a read operation by transaction T_i on a Data Item (A) W_i (B) Denote a write operation by transaction T_i on a Data Item B.

The Total number of conflict serializable schedule is____.

Without Schedule find # Conflict Serializable.

With Schedule: find # Conflict Serializable.

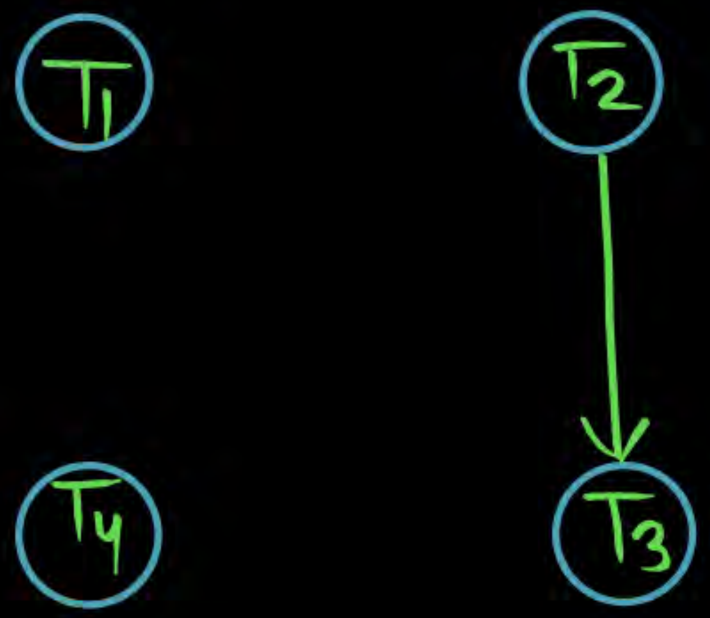
Q.4

Consider given schedule:

S: $r_1(x), r_2(y), w_3(y), r_4(x), w_4(z), w_3(y)$

How many conflict serializable schedules exists for the above schedule S?

T_1	T_2	T_3	T_4
r(x)			
	r(y)		
		w(y)	
			r(x)
			w(z)
		w(y)	



$T_2 \rightarrow T_3$

& T_1, T_4 Can be Pleaced Anywhere.

T_1 & T_4 can be place Anywhere.

first pick T_1

... ① ... T_2 ... ② ... T_3 ... ③ ...

3 place → $3!\ 2! = 12$ Ans

$T_1\ T_4$ arrange

CASE I ... T_4 ... T_1 ... T_4 ... T_2 ... T_4 ... T_3 ... T_4 ... $= 4$

CASE II ... T_2 ... T_1 ... T_3 ... $= 4$

CASE III ... T_2 ... T_3 ... T_1 ... $= 4$

12 Ans

CASE I

(i) $T_4\ T_1\ T_2\ T_3$

(ii) $T_1\ T_4\ T_2\ T_3$

(iii) $T_1\ T_2\ T_4\ T_3$

(iv) $T_1\ T_2\ T_3\ T_4$

4

Q.5

Consider the following schedule

$$S = r_1(P); r_3(S); w_1(Q); r_2(Q)\ r_4(Q), w_2(R);$$
$$r_5(R); w_4(T); r_5(T); w_5(Q)$$

How many serial schedules are possible which will be view equal to S? 10 Ans.

T_1	T_2	T_3	T_4	T_5
r(P)				
		r(S)		
w(Q)				
	r(Q)			
			r(Q)	
	w(R)			
				r(R)
			w(T)	
				r(T)
				w(Q)

① Initial Read : P: T_1 S: T_3

② Final Write : $\boxed{Q : T_1 \to T_5}$

③ Write-Read sequence [Updated Read]

$w_1(Q) - r_2(Q) : T_1 \to T_2$

$w_1(Q) - r_4(Q) : T_1 \to T_4$

$w_2(R) - r_5(R) : T_2 \to T_5$

$w_4(T) - r_5(T) : T_4 \to T_5$

Independent
T_3 Can be placed Any where

$T_1 \rightarrow T_5$

$T_1 \rightarrow T_2$
$T_1 \rightarrow T_4$ → T_1 appear before T_2 & T_4

$T_2 \rightarrow T_5$
$T_4 \rightarrow T_5$ → T_5 Appear After T_2 & T_4

T_2 & T_4

T_1 T_2 & T_4 T_5

T_3

CASE I ↑1 T_1 ↑2 T_2 ↑3 T_4 ↑4 T_5 ↑5 = 5

CASE II ↑ T_1 ↑ T_4 ↑ T_2 ↑ T_5 ↑ = 5

10 Ans

CASE I

1 T_3 T_1 T_2 T_4 T_5

2 T_1 T_3 T_2 T_4 T_5

3 T_1 T_2 T_3 T_4 T_5

4 T_1 T_2 T_4 T_3 T_5

5 T_1 T_2 T_4 T_5 T_3

5

CASE II

1 T_3 T_1 T_4 T_2 T_5

2 T_1 T_3 T_4 T_2 T_5

3 T_1 T_4 T_3 T_2 T_5

4 T_1 T_4 T_2 T_3 T_5

5 T_1 T_4 T_2 T_5 T_3

5

(1)

<table>
<tr><th>T_1</th><th>T_2</th></tr>
<tr><td>W(A)</td><td></td></tr>
<tr><td></td><td>R(A)</td></tr>
<tr><td>C|R</td><td></td></tr>
<tr><td></td><td>Commit</td></tr>
</table>

Recoverable

(2)

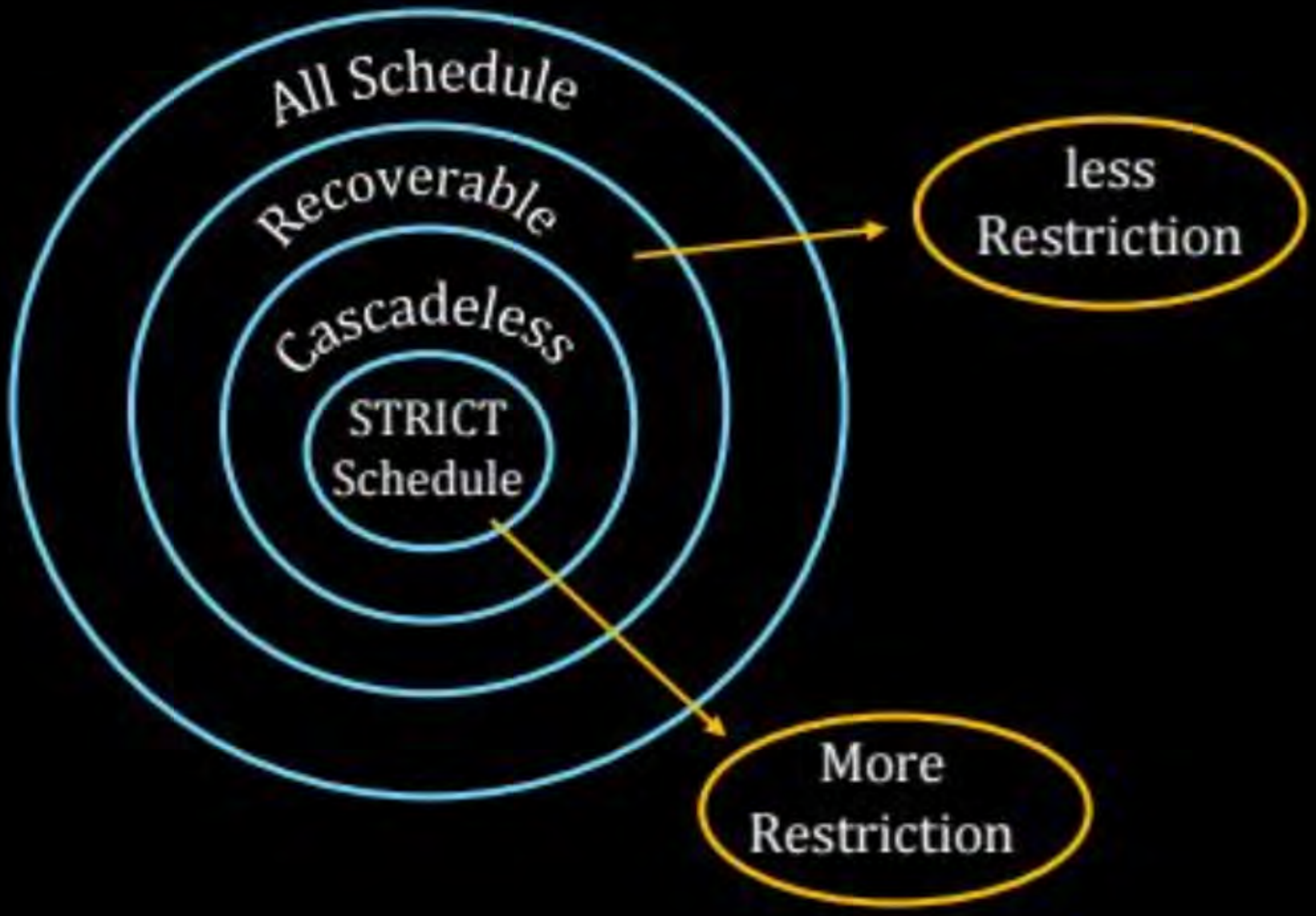
<table>
<tr><th>T_1</th><th>T_2</th></tr>
<tr><td>W(A)</td><td></td></tr>
<tr><td>C|R</td><td></td></tr>
<tr><td></td><td>R(A)</td></tr>
</table>

Cascadeless

(3)

<table>
<tr><th>T_1</th><th>T_2</th></tr>
<tr><td>W(A)</td><td></td></tr>
<tr><td>C|R</td><td></td></tr>
<tr><td></td><td>R(Q)/W(Q)</td></tr>
</table>

Strict schedule


All Schedule
Recoverable
Cascadeless
STRICT
Schedule
less
Restriction
More
Restriction

Q.

Consider the following database schedule with two transactions, T_1 and T_2.

$S = r_2(X); r_1(X); r_2(Y); w_1(X); r_1(Y); w_2(X); a_1; a_2$

where $r_i(Z)$ denotes a read operation by transaction T_i on a variable Z, $w_i(Z)$ denotes a write operation by T_i on a variable Z and a_i denotes an abort by transaction T_i

Which one of the following statements about the above schedule is TRUE?

[MCQ:2016–2M]

T_1	T_2
	$r(X)$
$r(X)$	
	$r(y)$
$w(X)$	
$r(y)$	
	$w(X)$
a_1	
	a_2

(A) S is non-recoverable

(B) S is recoverable, but has a cascading abort/Rollback

(C) S does not have a cascading abort

(D) S is strict

Because S is cascadeless

✓ Recoverable.

✓ Cascadeless.

(No Uncommitted Read)

✗ Strict Recoverable.

∴ Not Strict

(b) is True Only when Schedule is Recoverable but Not Cascadeless.

T_1	T_2
W(A)	
	R(A)
C/R	
	·Commit

Recoverable

T_1	T_2
W(A)	
C/R	
	R(A)

Cascadeless.

[No Cascading Rollback/abort)

T_1	T_2
W(A)	
C/R	
	R(A) / W(A)

Strict Recoverable

Q.

Let S be the following schedule of operations of three transactions T_1, T_2 and T_3 in a relational database system:

$$R_2(Y), R_1(X), R_3(Z), R_1(Y), W_1(X), R_2(Z), W_2(Y), R_3(X), W_3(Z)$$

Consider the statements P and Q below:

P: S is conflict-serializable.

Q: If T_3 commits before T_1 finishes, then S is recoverable.

Which one of the following choices is correct?

[MCQ: 2021-2M]

(A) Both P and Q are true.

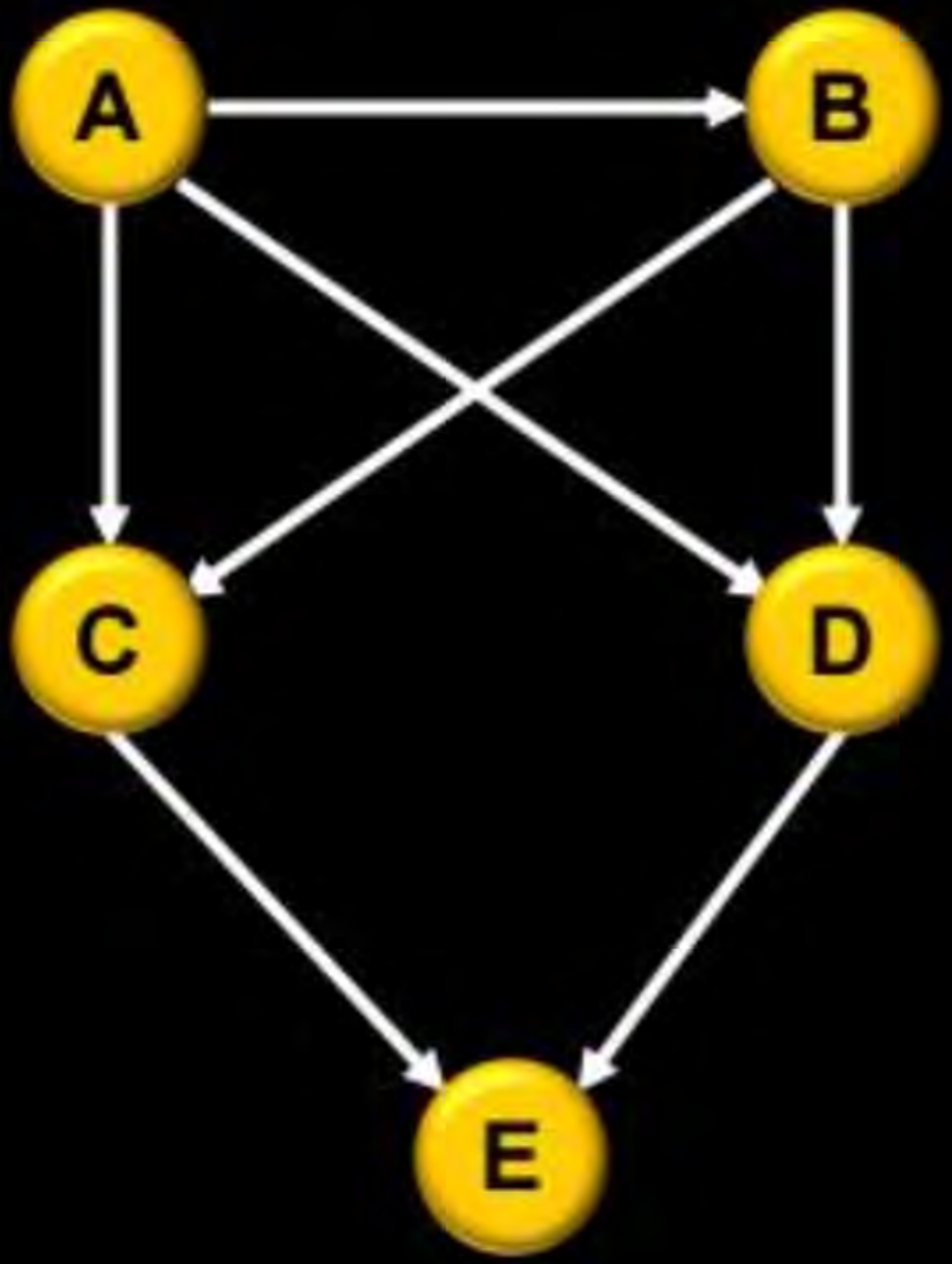
(B) P is true and Q is false.

(C) P is false and Q is true.

(D) Both P and Q are false.

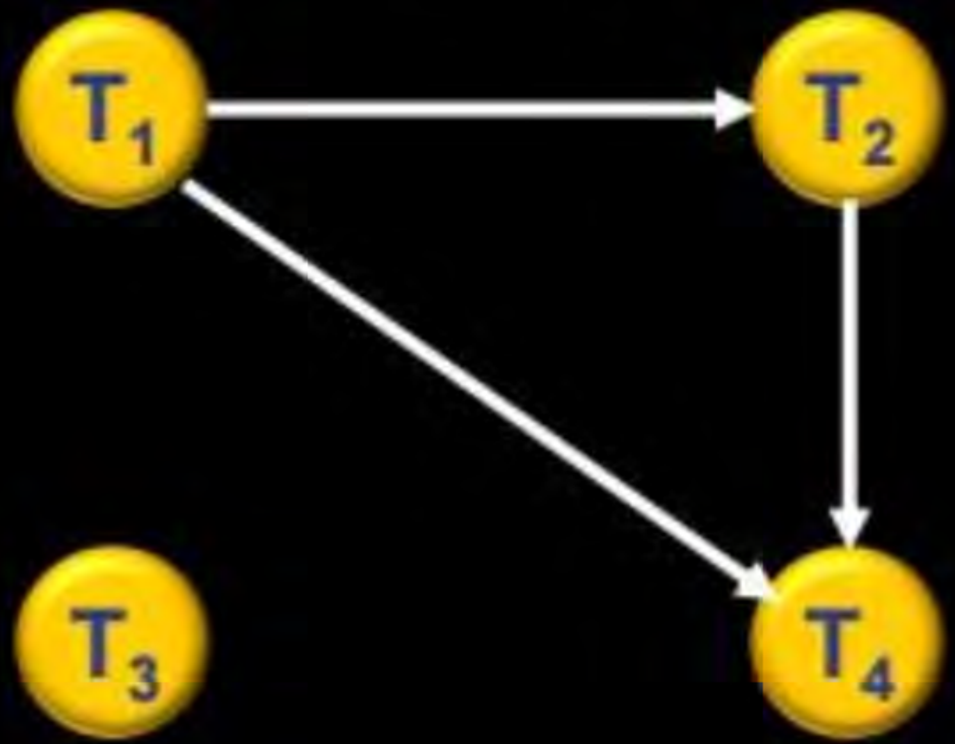
Topological Sorting

Q.



Topological Sorting

Q.

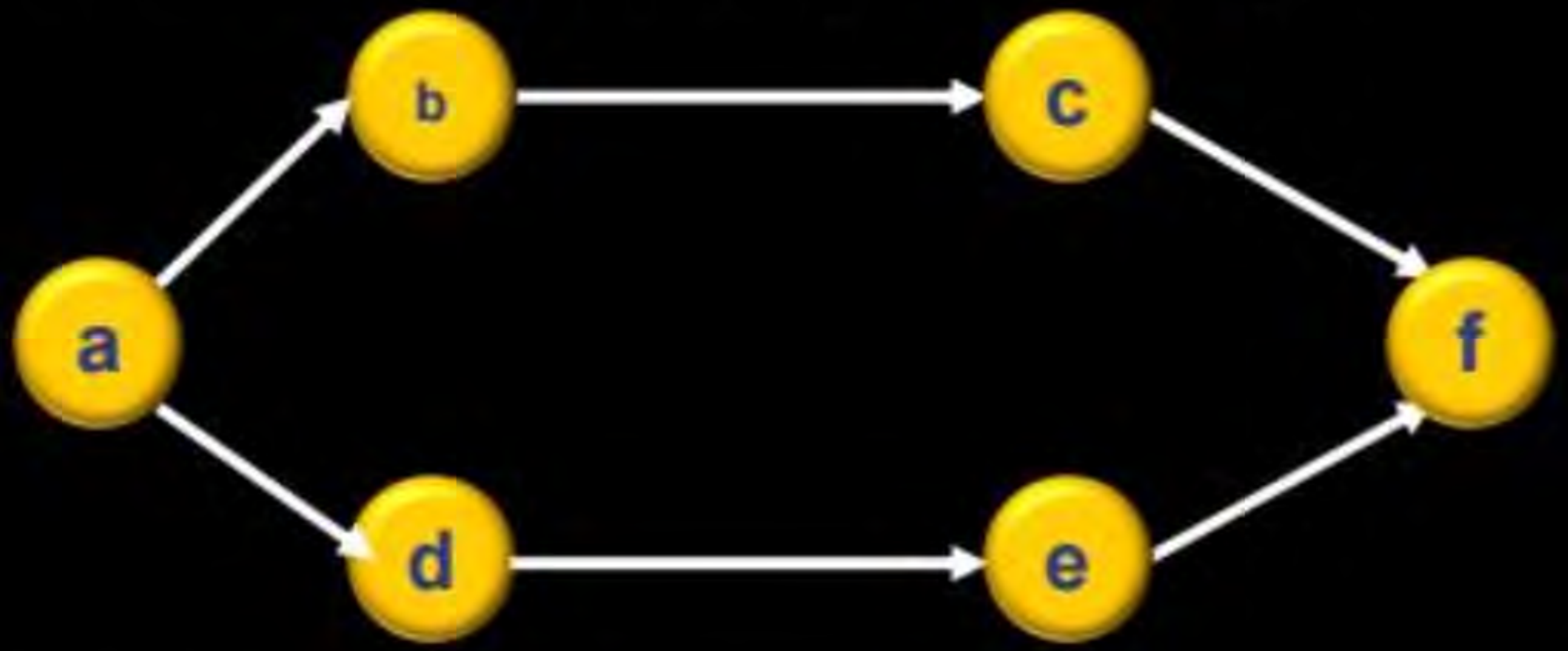


Topological Sorting

Q. $R_4(A)\ R_2(A)\ R_3(A)\ W_1(B)\ W_2(A)\ R_3(B)\ W_2(B)$

Topological Sorting

Q. Consider the following directed graph:



The number of different topological ordering of the vertices of the graph is ________.

[MCQ: 2016]

THANK YOU!