

CSCI235 Database Systems

Introduction to Transaction Processing (2)

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Introduction to Transaction Processing

Outline

Correctness

Conflict serializability versus view serializability

Order preserving conflict serializability

Recoverable executions

Cascadeless executions

Strict executions

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Correctness

What makes concurrent execution of database transaction **incorrect** ?

How do we define a **correct** concurrent execution of database transactions ?

Concurrent execution of database transactions is **view serializable** if there **exists a possible serial execution of the same set of transactions** such that in both executions each **transaction reads the same values and the final states of the database are the same**

A concurrent execution of database transactions is **correct** when it is **view serializable**

Correctness

A sample **view serializable** execution of database transactions

Concurrent processing of database transactions	
T1	T2
read(x)	
write(x, x-10)	
	read(x)
read(y)	
write(y, y+10)	
	read(y)

The execution of database transactions above is **view serializable** because there exists a **serial execution** of the same transactions such that in both executions the transactions **read the same values and the final states of the database are the same** (see next slide)

Correctness

A sample serial execution equivalent to a concurrent execution from the previous slide

Concurrent processing of database transactions	
T1	T2
read(x)	
write(x, x-10)	
read(y)	
write(y, y+10)	
	read(x)
	read(y)

Correctness

A problem with **view serializability**

- Verification that concurrent execution of Database transactions is **view serializable** is **NP-complete**
- It means that it takes to much time to check whether execution of a database operation violates **view serializability** correctness criterion

A more practical correctness criterion is **conflict serializability**

- Concurrent execution of database transactions is **conflict serializable** if there exists a possible serial execution of the same set of transactions such that in both executions **the order of conflicting operations** is the same

Which operations are **conflicting operations** ?

Two perations are **conflicting operations** if both **access the same data item** and one or both of them is **write** operation

	read	write	Conflicting operations
read	NO	YES	
write	YES	YES	

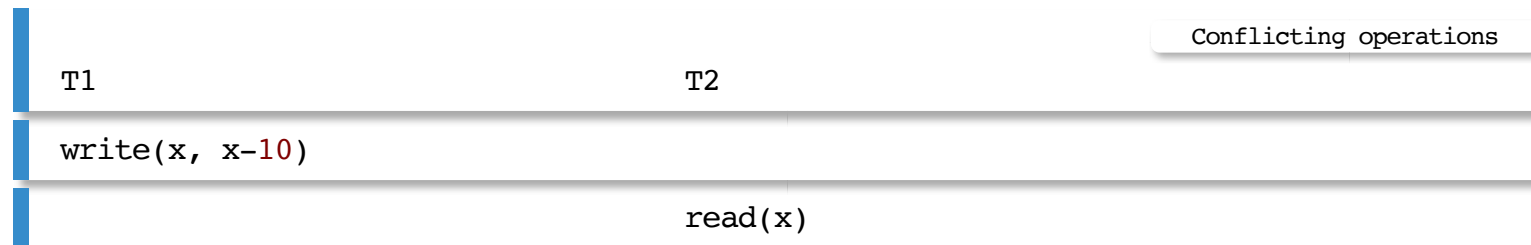
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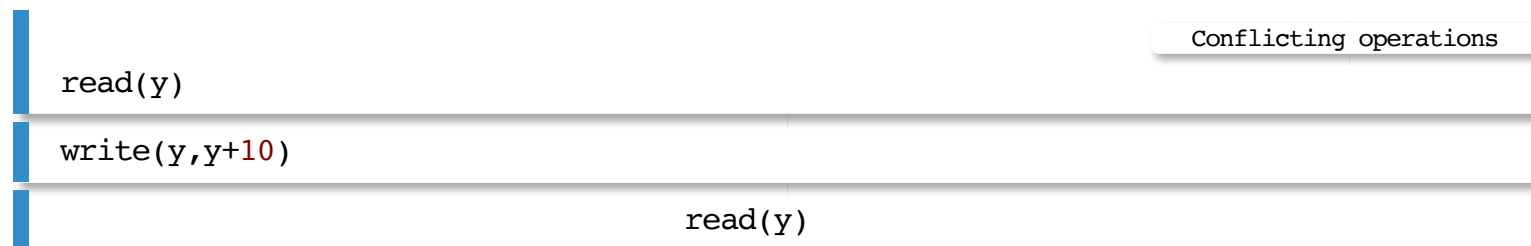
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Correctness

Conflicting operations in a sample concurrent execution of database transactions



The operations `write(x, x-10)` and `read(x)` are **conflicting operations** because both access the same data item `x` and one of them is `write`



The operations `write(y, y+10)` and `read(y)` are **conflicting operations** because both access the same data item `y` and both of them are `write`

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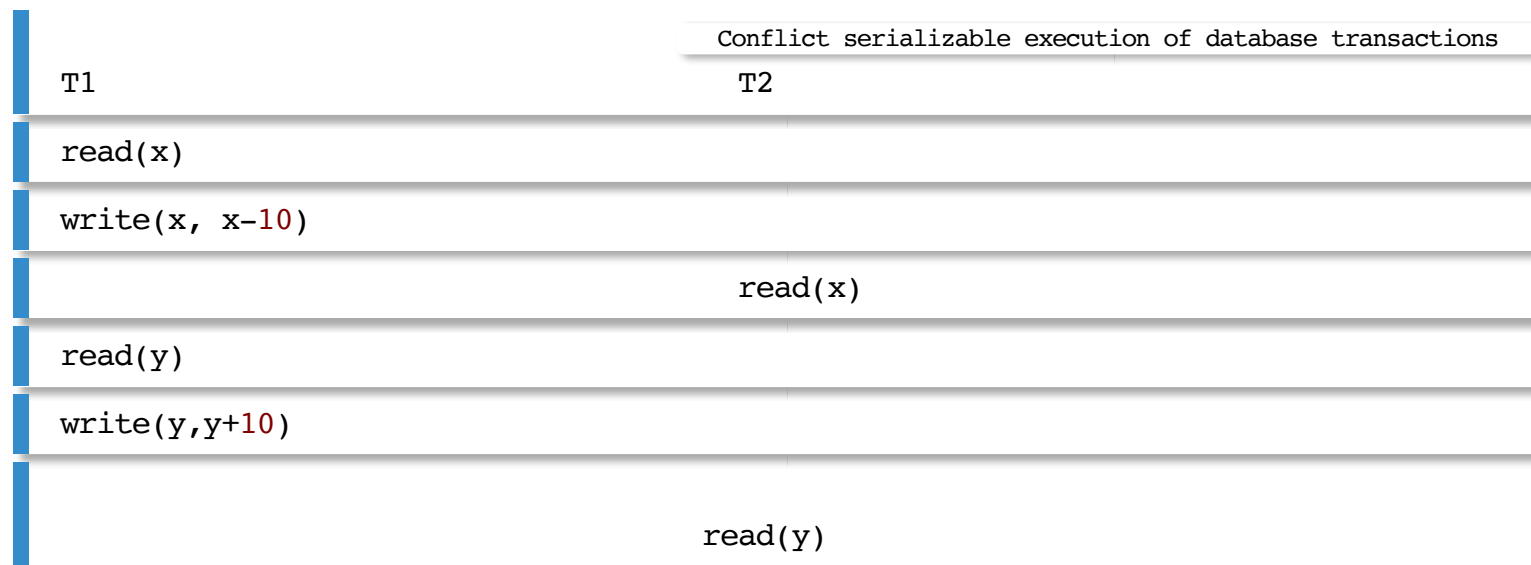
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Correctness

Concurrent execution of database transactions is **conflict serializable** if there exists a **possible serial execution** of the same set of transactions such that in both executions **the order of conflicting operations is the same**

A sample **conflict serializable** execution of database transactions



Order of conflicting operations: **T1 before T2**

Correctness

A sample **nonconflict serializable** execution of database transactions

Nonconflict serializable execution of database transactions		
T1	T2	x = \$100
read(x)		
	read(x)	x = \$100
write(x, x-10)		x = \$90
	write(x, x+20)	x = \$120
	commit	x = \$120
commit		x = \$120

Order of conflicting operations: **T1 before T2** and **T2 before T1** means that it is **impossible to serialize** the concurrent execution of **T1** and **T2**

It means that the concurrent execution of database transactions **T1** and **T2** is **incorrect**

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Conflict serializability versus view serializability

Every **conflict serializable** execution is **view serializable**

A **view serializable** execution **may not be conflict serializable**

An execution below is **view serializable** because there exists equivalent **serial execution** where each transaction reads and writes the same data items, see next slide

View serializable execution of database transactions		
T1	T2	T3
write(x, 10)		
	write(x, 20)	
		write(x, 30)
	write(y, 10)	
read(y)		

Conflict serializability versus view serializability

Equivalent **serial execution**

Serial execution of database transactions		
T1	T2	T3
	write(x, 20)	
	write(y, 10)	
write(x, 10)		
read(y)		
		write(x, 30)

Hence, the original execution is **view serializable**

Conflict serializability versus view serializability

However, the original execution is **not conflict serializable**

Not conflict serializable execution of database transactions		
T1	T2	T3
write(x, 10)		
	write(x, 20)	
		write(x, 30)
	write(y, 10)	
read(y)		

This is because **T1** processes a conflicting operation `write(x, 10)` before **T2** processes `write(x, 20)` and **T2** processes a conflicting operation `write(y, 10)` before **T1** processes `read(y)`

Hence, the execution is **not conflict serializable**

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Order preserving serializability

Concurrent execution of database transactions is **order-preserving conflict serializable** if it is

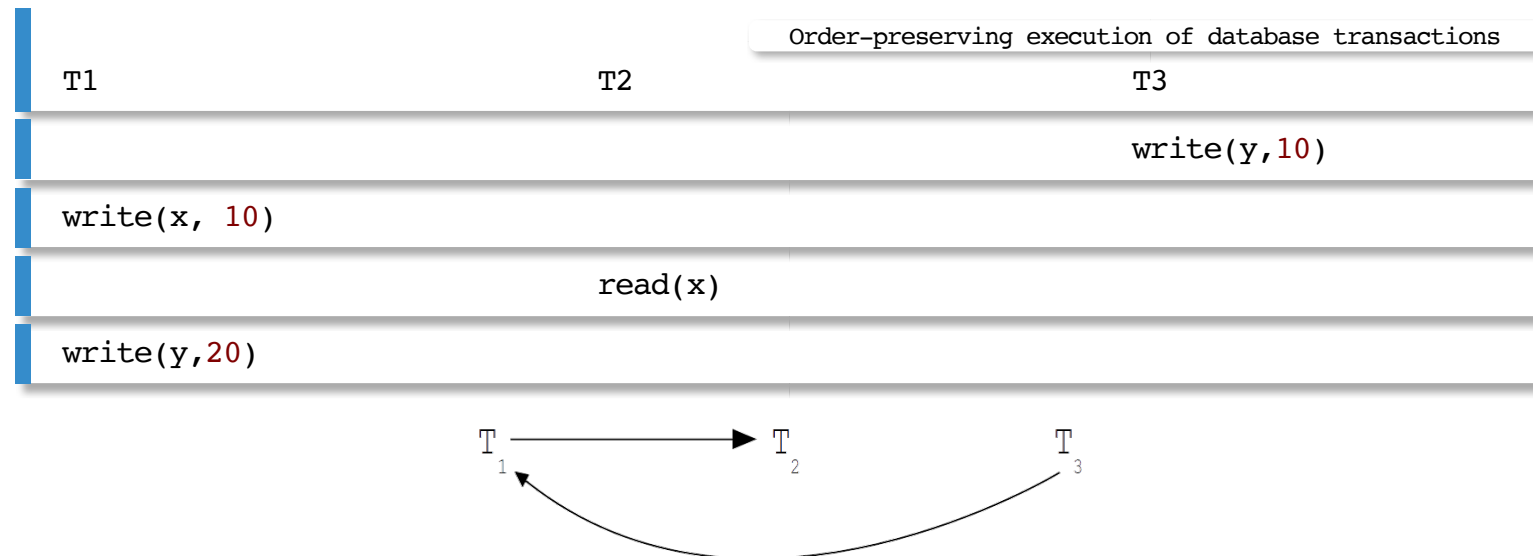
- conflict serializable and
- all non-interleaved transactions have the same order in both original execution and some corresponding serial execution

Every **order-preserving conflict serializable** execution is **conflict serializable**

A **conflict serializable** execution may **not be order-preserving conflict serializable**

Order preserving serializability

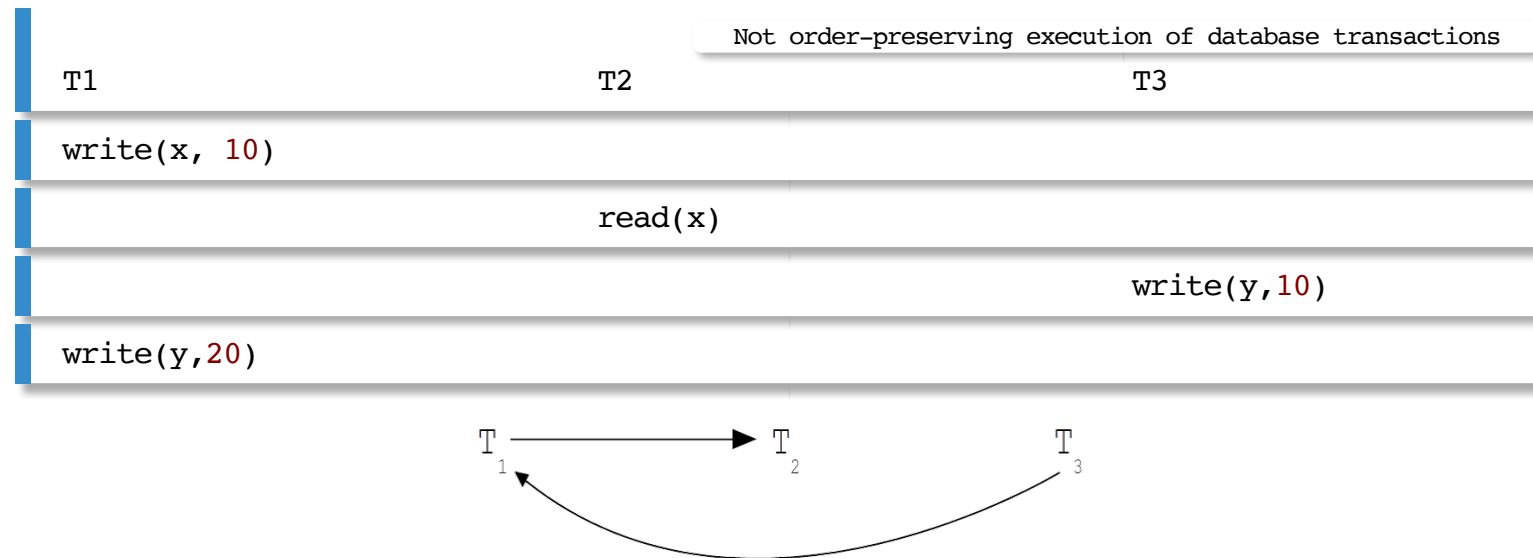
A sample **conflict serializable** and **order-preserving serializable** execution



Order of transactions indicated by their start timestamps is the same as serialization order (T3 before T1 and T1 before T2)

Order preserving serializability

A sample **conflict serializable** and **not order-preserving serializable** execution



The execution is **not order-preserving serializable** because order of transactions indicated by their start timestamps (**T1** before **T2** and **T2** before **T3**) is different from serialization order (**T3** before **T1** and **T1** before **T2**)

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Recoverable executions

Transaction manager must provide the all-or-nothing property of transactions even in the presence of **various types of failures**

Execution is **recoverable** if every transaction **T** that reads a data item written by another transaction **T'** commits after **T'** is committed

A sample **nonrecoverable** execution

Nonrecoverable execution of database transactions		
T1	T2	
		x = \$100
read(x)		x = \$100
write(x, x-10)		x = \$90
	read(x)	x = \$90
	write(x, x+20)	x = \$110
	commit	x = \$110
abort		x = \$100

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Cascadeless executions

Execution is **cascadeless** if none of the transactions reads data item written by any other transaction that is not committed or aborted

A sample **cascadeless** execution

Cascadeless execution of database transactions		
T1	T2	x
		x = \$100
read(x)		x = \$100
write(x, x-10)		x = \$90
	read(x) wait	x = \$90
abort		x = \$100
	write(x, x+20)	x = \$120

Cascadeless executions

A sample **noncascadeless** execution

Noncascadeless execution of database transactions		
T1	T2	
		x = \$100
read(x)		x = \$100
write(x, x-10)		x = \$90
	read(x)	x = \$90
	write(x, x+20)	x = \$110
abort		x = \$100
	forced abort	x = \$100

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Strict executions

Execution is **strict** if any data item **d** is written by transaction **T** then any other transaction cannot either read or write data item **d** until **T** is committed or aborted

A sample **strict** execution

Strict execution of database transactions		
T1	T2	x = \$100
read(x)		x = \$100
write(x, x+10)		x = \$110
	write(x,20) wait	x = \$110
abort		x = \$100
	write(x,20)	x = \$20
	commit	x = \$20

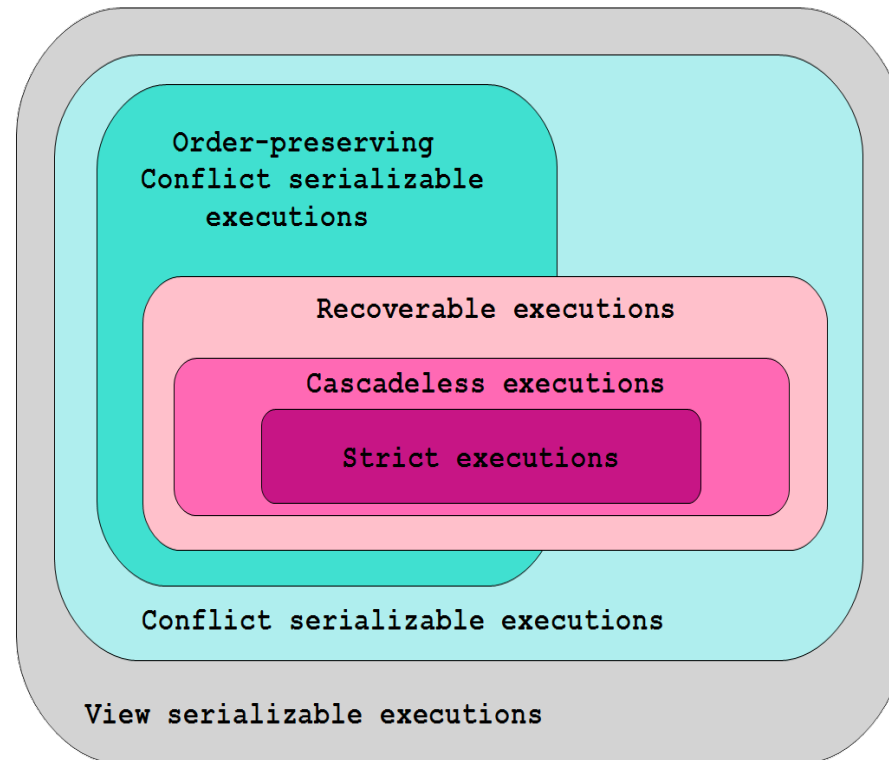
Strict executions

A sample **nonstrict** execution

Nonstrict execution of database transactions		
T1	T2	
		x = \$100
read(x)		x = \$100
write(x, x+10)		x = \$110
	write(x, 20)	x = \$20
	commit	x = \$20
abort		x = \$100

Rollback of T1 destroys committed T2 :write(x, 20)

Summary



References

T. Connolly, C. Begg, Database Systems, A Practical Approach to Design, Implementation, and Management, Chapter 22.1 Transaction Support, Chapter 22.2 Concurrency Control, Pearson Education Ltd, 2015