ICS 321 Data Storage & Retrieval

Transactions Processing (i)

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Airline Reservation Example

```
Flights ( fltNo , fltDate , seatNo , seatStatus )
```

To view available seats:

```
SELECT seatNo
FROM Flights
WHERE fltNo = 123 AND fltDate = DATE '2008-12-25'
        AND seatStatus = ' available ' ;
```

To reserve a particular seat:

```
UPDATE Flights
SET seatStatus = 'occupied'
WHERE fltNo = 123 AND fltDate = DATE '2008-12-25 '
        AND seatNo = '22A';
```

Transactions

- A *transaction* is the DBMS's abstract view of a user program: a sequence of reads and writes.
  - Eg. User 1 views available seats and reserves seat 22A.
- A DBMS supports multiple users, ie, multiple transactions may be running concurrently.
  - Eg. User 2 views available seats and reserves seat 22A.
  - Eg. User 3 views available seats and reserves seat 23D.

Concurrent Execution

- DBMS tries to execute transactions concurrently – why ?

Schedule 1

U1	U2
Finds 22A empty	
	Finds 22A empty
Reserves 22A	
	Reserves 22A

Schedule 2

U1	U2
Finds 22A empty	
Reserves 22A	
	Finds 22A taken
	Does not reserve 22A

Schedule 3

U1	U2
	Finds 22A empty
	Reserves 22A
Finds 22A taken	
Does not reserve 22A	

ACID Properties

4 important properties of transactions

- **Atomicity**: all or nothing
  - Users regard execution of a transaction as atomic
  - No worries about incomplete transactions
- **Consistency**: a transaction must leave the database in a good state
  - Semantics of consistency is application dependent
  - The user assumes responsibility
- **Isolation**: a transaction is isolated from the effects of other concurrent transaction
- **Durability**: Effects of completed transactions persists even if system crashes before all changes are written out to disk

Atomicity

- A transaction might
  - *commit* after completing all its actions, or it could
  - *abort* (or be aborted by the DBMS) after executing some actions.
- A very important property guaranteed by the DBMS for all transactions is that they are *atomic.*
  - A user can think of a Xact as always executing all its actions in one step, or not executing any actions at all.
- DBMS *logs* all actions so that it can *undo* the actions of aborted transactions.

Example (Atomicity)

```
T1:     BEGIN
        A=A+100
        B=B-100
        END
```

```
T2:     BEGIN
        A=1.06*A
        B=1.06*B
        END
```

- The first transaction is transferring $100 from B’s account to A’s account.
- The second is crediting both accounts with a 6% interest payment
- There is no guarantee that T1 will execute before T2 or vice-versa, if both are submitted together. However, the net effect must be equivalent to these two transactions running serially in some order.

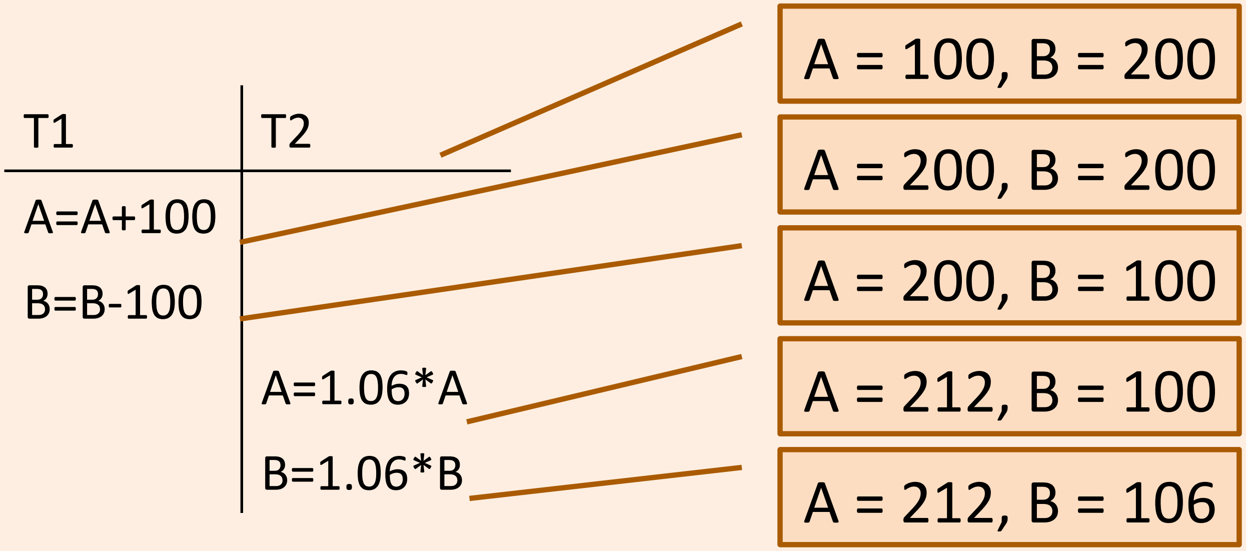
Database View of Transactions

```
T1:     BEGIN
        A=A+100
        B=B-100
        END
```

```
T1:     BEGIN

        Read A from disk
         A=A+100
         Write A to disk

        Read B from disk
        B=B-100
        Write B to disk

        END
```

```
T1:     BEGIN
        R(A)
        W(A)
        R(B)
        W(B)
        END
```

Serial Executions



T1	T2
A=A+100	
B=B-100	
	A=1.06*A
	B=1.06*B

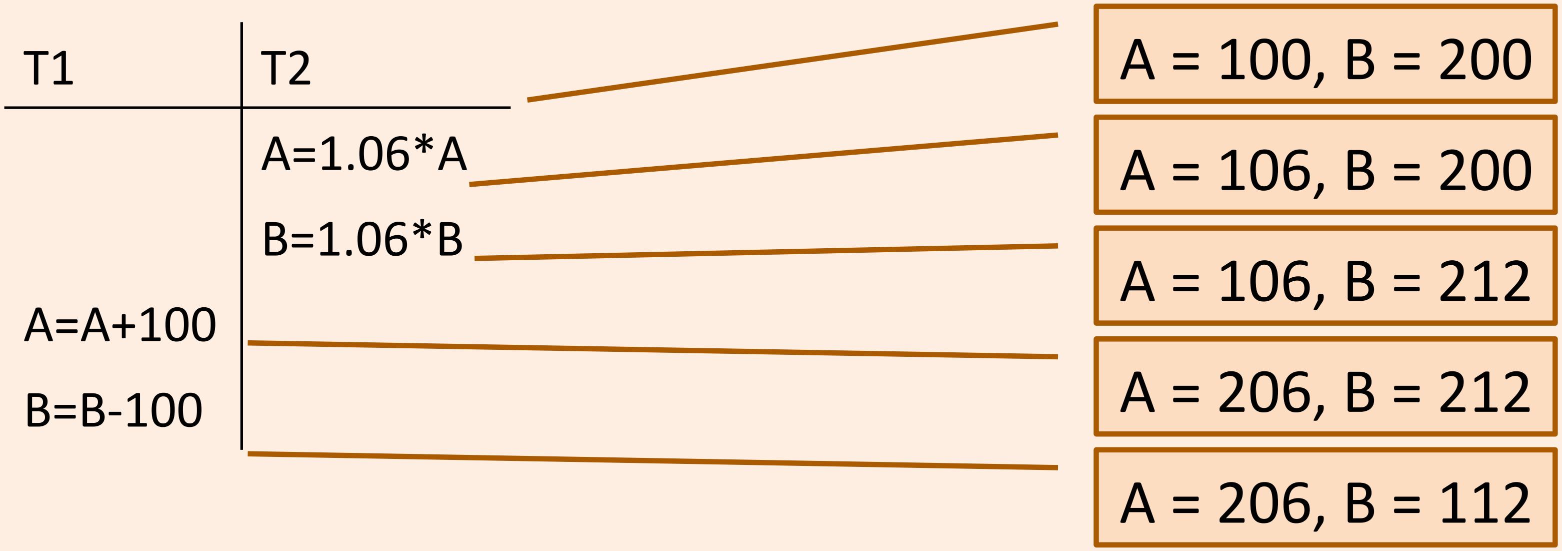
A = 100, B = 200

A = 200, B = 200

A = 200, B = 100

A = 212, B = 100

A = 212, B = 106



T1	T2
	A=1.06*A
	B=1.06*B
A=A+100	
B=B-100	

A = 100, B = 200

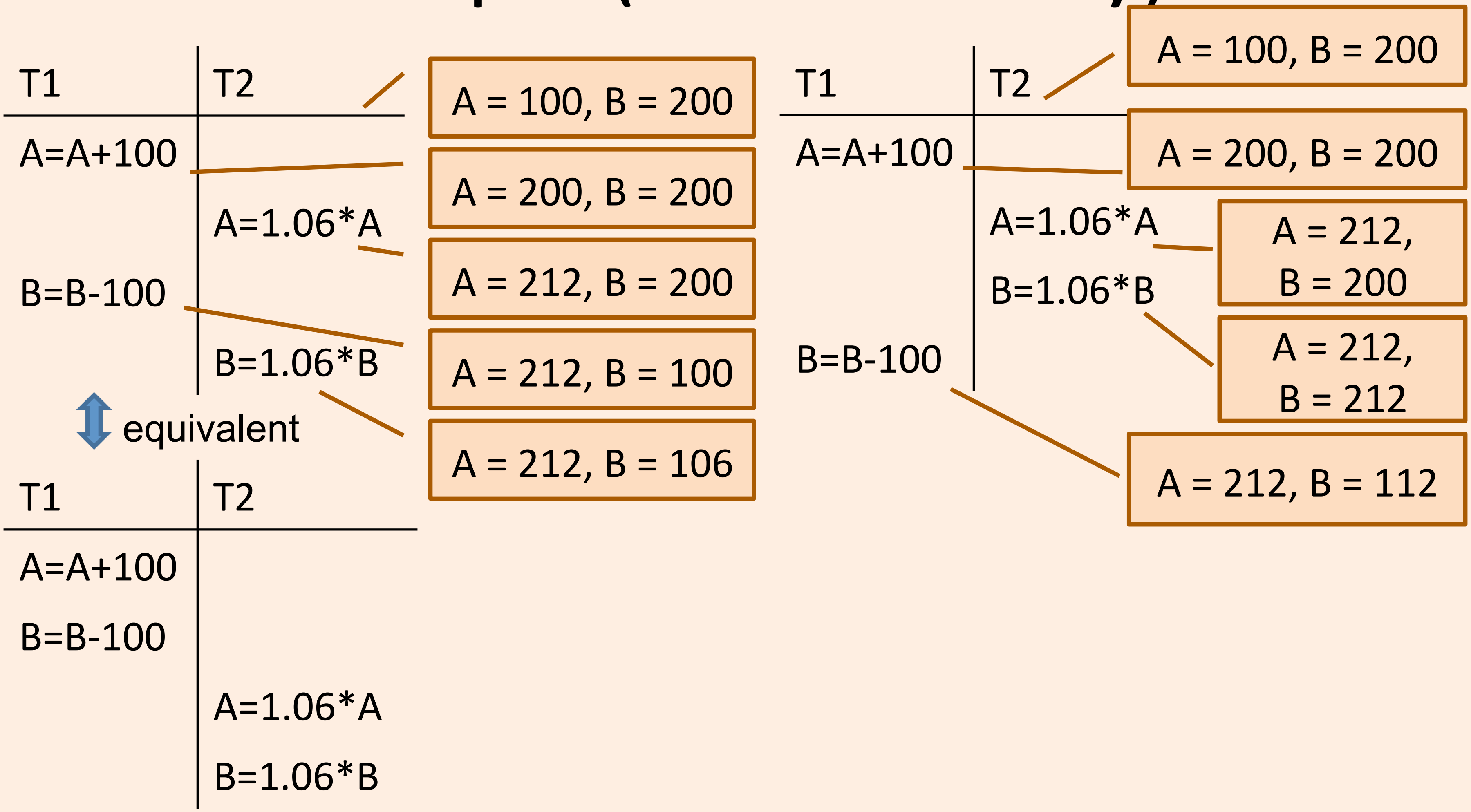
A = 106, B = 200

A = 106, B = 212

A = 206, B = 212

A = 206, B = 112

Example (Serializability)



T1	T2
A=A+100	
	A=1.06*A
B=B-100	
	B=1.06*B

A = 100, B = 200

A = 200, B = 200

A = 212, B = 200

A = 212, B = 100

A = 212, B = 106

⇕ equivalent

T1	T2
A=A+100	
B=B-100	
	A=1.06*A
	B=1.06*B

T1	T2
A=A+100	
	A=1.06*A
	B=1.06*B
B=B-100	

A = 100, B = 200

A = 200, B = 200

A = 212,
B = 200

A = 212,
B = 212

A = 212, B = 112

Scheduling Transactions

- *Serial schedule:* Schedule that does not interleave the actions of different transactions.
- *Equivalent schedules*: For any database state, the effect (on the set of objects in the database) of executing the first schedule is identical to the effect of executing the second schedule.
- *Serializable schedule*: A schedule that is equivalent to some serial execution of the transactions.

(Note: If each transaction preserves consistency, every serializable schedule preserves consistency.)

Transactions in SQL

- After connection to a database, a transaction is automatically started
  - Different connections -> different transactions
- Within a connection, a transaction is ended by
  - **COMMIT** or **COMMIT WORK**
  - **ROLLBACK** (= "abort")
- DBMS can also initiate rollback and return an error.
- **SAVEPOINT** <savepoint name>
- **ROLLBACK TO SAVEPOINT** <savepoint name>
  - Locks obtained after savepoint can be released after rollback to that savepoint
- Using savepoints vs sequence of transactions
  - Transaction rollback is to last transaction only

Isolation levels in SQL

- SQL supports 4 isolation levels

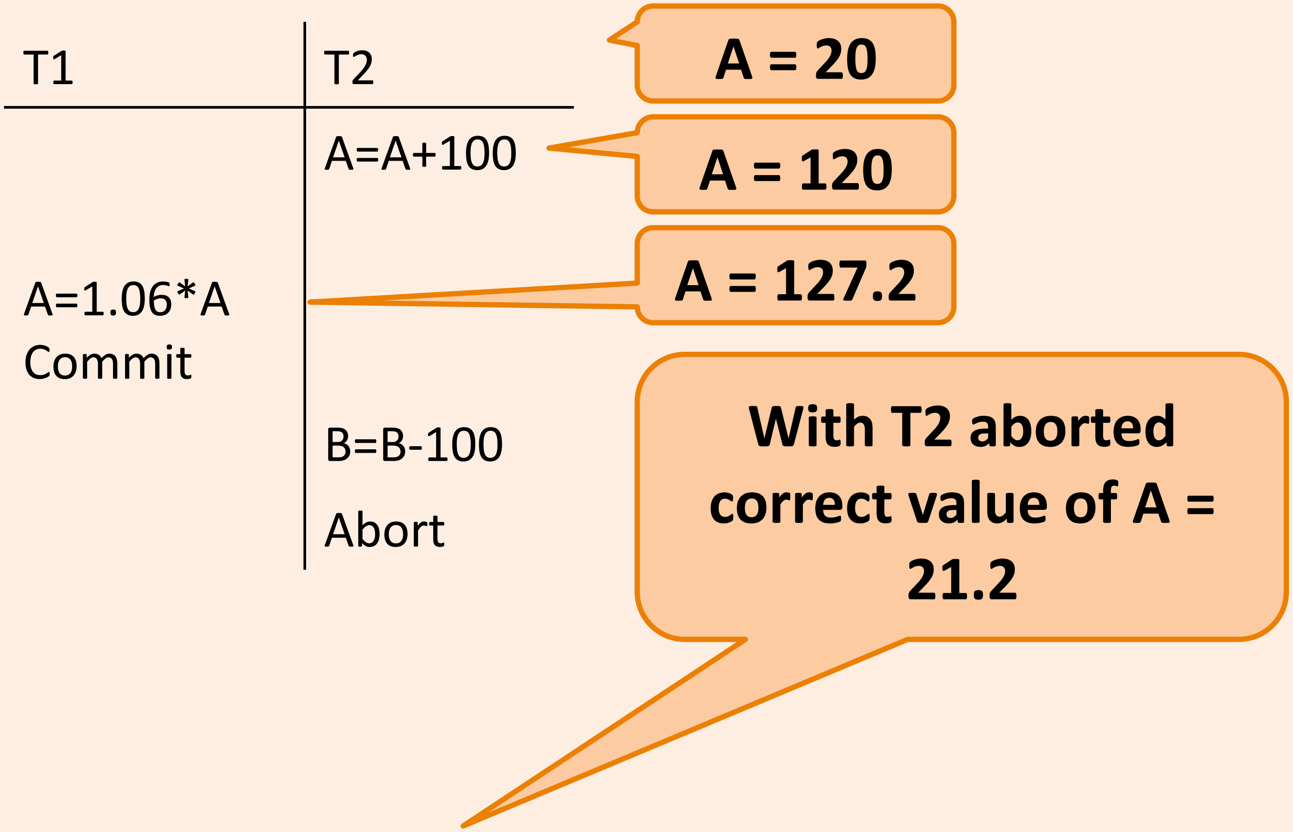
SQL Isolation Levels	DB2 Isolation Levels	Dirty read	Unrepeatable Read	Phantom
READ UNCOMMITTED	UNCOMMITTED READ (**UR**)	Maybe	Maybe	Maybe
READ COMMITTED	CURSOR STABILITY * (**CS**)	No	Maybe	Maybe
REPEATABLE READ	READ STABILITY (**RS**)	No	No	Maybe
SERIALIZABLE	REPEATABLE READ (**RR**)	No	No	No

```
SET TRANSACTION ISOLATION LEVEL   SERIALIZABLE
```

```
SELECT *
FROM Reserves
WHERE SID=100
WITH UR
```

Anomaly: Dirty Reads

- T1 reads uncommitted data from T2 which may abort



T1	T2
	A=A+100
A=1.06*A	
Commit	
	B=B-100
	Abort

A = 20

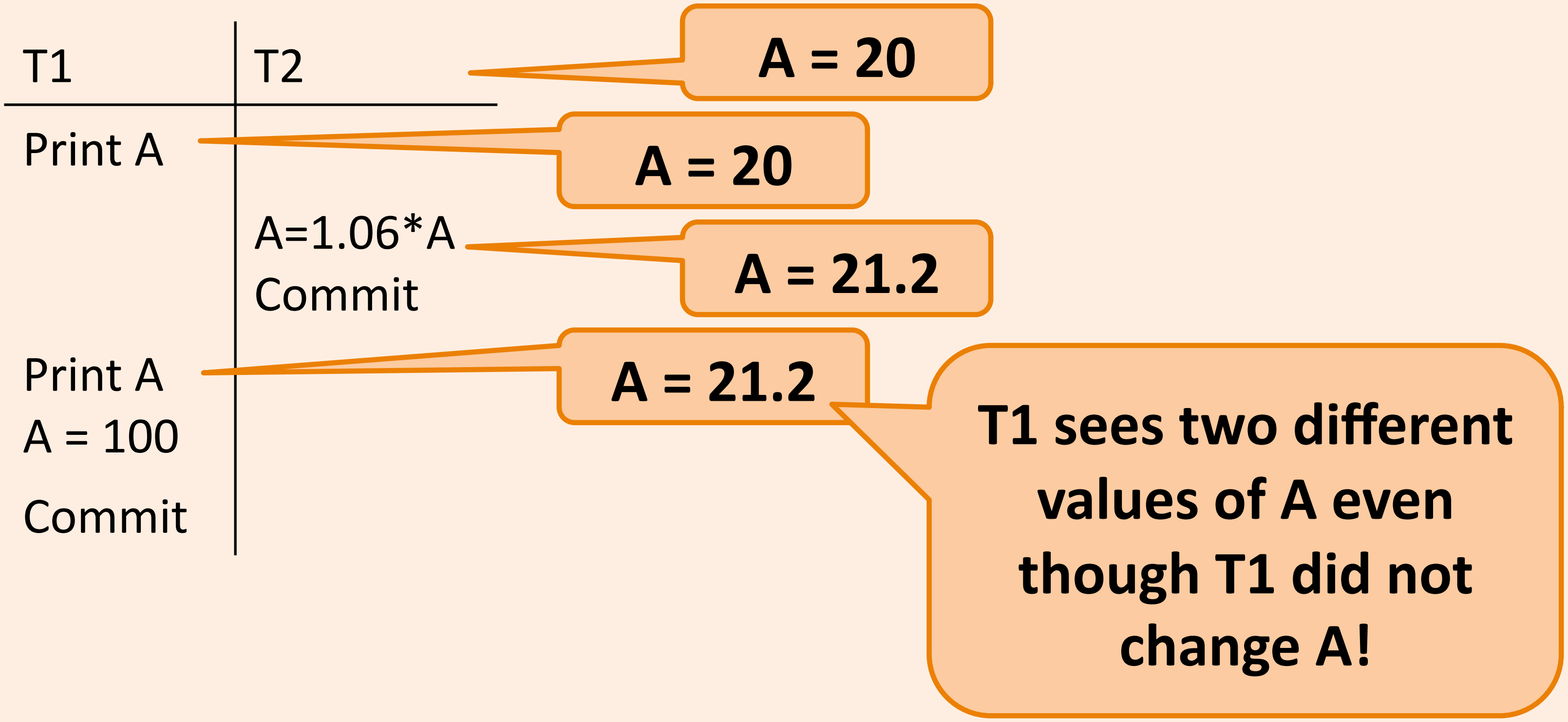
A = 120

A = 127.2

With T2 aborted correct value of A = 21.2

Anomaly: Unrepeatable Reads

- T1 sees two different values of A, because updates are committed from another transaction (T2)



T1	T2
Print A	
	A=1.06*A
	Commit
Print A	
A = 100	
Commit	

A = 20

A = 20

A = 21.2

A = 21.2

T1 sees two different values of A even though T1 did not change A!

Anomaly: Phantom Reads

- Multiple reads from the same transaction sees different set of tuples

T1	T2
Find all ics321 students	
	Enroll student D into ics321
	Commit
Find all ics321 students	
Commit	

{A,B,C}

Insert D

{A,B,C,D}

T1 sees two different results of the query even though T1 did not change the table!