Transaction Management - Concurrence Control

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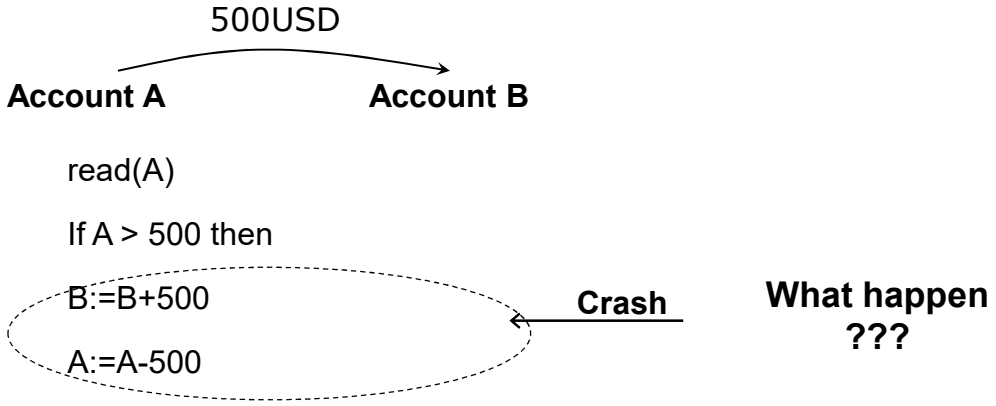
Learning objectives

- ***Upon completion of this lesson, students will be able to:***
  1. Understand main concepts of transaction
  2. Be able to select a suitable transaction management strategy

Outline

1. Transaction
2. ACID properties
3. Transaction Management Interface
4. Concurrence control
5. Isolation levels

Example



1. Transaction

- A sequence of read and write operations on data items that logically functions as one unit of work
  - Ensuring data integrity and correctness

read(A)

If A > 500 then

B:=B+500

A:=A-500

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2. ACID Properties

2.1. Atomicity
2.2. Consistency
2.3. Isolation
2.4. Durability

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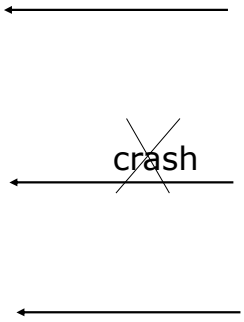
2.1. Atomicity

- Guarantee that either all of the tasks of a transaction are performed or none of them are.

```
T: Read(A,t1);
   If t1 > 500 {
    Read(B,t2);
    t2:=t2+500;
    Write(B,t2);
    t1:=t1-500;
    Write(A,t1);
   }
```



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2.2. Consistency

- Ensures that the DB remains in a consistent state before the start of the transaction and after the transaction is over.

```
T: Read(A,t1);
   If t1 > 500 {
    Read(B,t2);
    t2:=t2+500;
    Write(B,t2);
    t1:=t1-500;
    Write(A,t1);
   }
```

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2.3. Isolation

- Ability of the application to make operations in a transaction appear isolated from all other operations.

A= 5000, B= 3000

```
T: Read(A,t1);
   If t1 > 500 {
    Read(B,t2);
    t2:=t2+500;
    Write(B,t2);        ← T': A+B
                          (= 5000+3500)
    t1:=t1-500;
    Write(A,t1);        ← (A+B = 4500+3500)
   }
```

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2.4. Durability

- Guarantee that once the user has been notified of success, the transaction will persist, and not be undone.

A= 5000, B= 3000

```
T: Read(A,t1);
   If t1 > 500 {
    Read(B,t2);
    t2:=t2+500;
    Write(B,t2);
    t1:=t1-500;
    Write(A,t1);
   }                    ← crash
```

A= 4500, B=3500

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3. Transaction Management Interface

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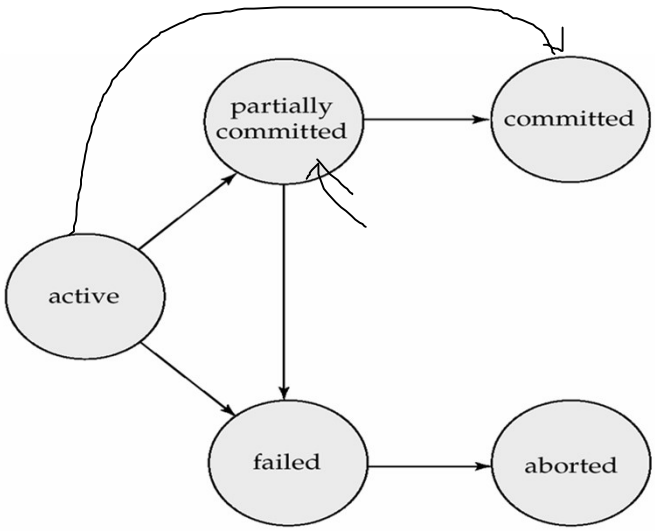
3.1. Transaction States

- Active
- Failed
- Aborted
- Commited
- Partially commited



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3.1. Transaction States

- Active
- Begin Trans
- Commit ()
- Abort()
- Savepoint Save()
- Rollback (savepoint)

  (savepoint = 0 ==> Abort)

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4. Concurrent control

4.1. Objective

4.2. Scheduling

4.3. Lock

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4.1. Objective

- Ensures that database transactions are performed concurrently without the concurrency violating the data integrity.
- Guarantees that no effect of committed transactions is lost, and no effect of aborted (rolled back) transactions remains in the related database.
- Example

```
T0:  read(A);              T1:   read(A);
     A := A -50;                 temp := A *0.1;
     write(A);                   A := A -temp;
     read(B);                   write(A);
     B := B + 50;              read(B);
     write(B);                  B := B + temp;
                                write(B);
```

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4.2. Scheduling

T_0	T_1
read(A)	
A := A - 50	
write(A)	
read(B)	
B := B + 50	
write(B)	
	read(A)
	temp := A * 0.1
	A := A -temp
	write(A)
	read(B)
	B := B + temp
	write(B)

(1)

T_0	T_1
	read(A)
	temp := A * 0.1
	A := A -temp
	write(A)
	read(B)
	B := B + temp
	write(B)
read(A)	
A := A - 50	
write(A)	
read(B)	
B := B + 50	
write(B)	

(2)

T_0	T_1
read(A)	
A := A - 50	
	read(A)
	temp := A * 0.1
	A := A -temp
	write(A)
	read(B)
write(A)	
read(B)	
B := B + 50	
write(B)	
	B := B + temp
	write(B)

(3)

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4.2. Scheduling

- A schedule of a set of transactions is a linear ordering of their actions
  - e.g. for the simultaneous deposits example:

    R1(X) R2(X) W1(X) W2(X)
- A serial schedule is one in which all the steps of each transaction occur consecutively
- A serializable schedule is one which is equivalent to some serial schedule

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4.3. Lock

- Lock: a synchronization mechanism for enforcing limits on access to DB in concurrent way.
  - one way of enforcing concurrency control policies
- Lock types
  - Shared lock (LS) readable but can not write
  - Exclusive lock (LX): read and write
  - UN(D): unlock
- Compatibility

	LS	LX
LS	true	false
LX	false	false

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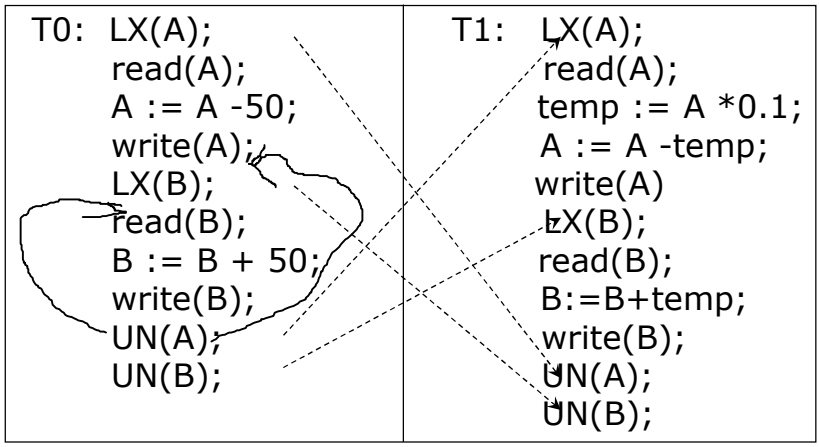
4.3. Lock

- Example



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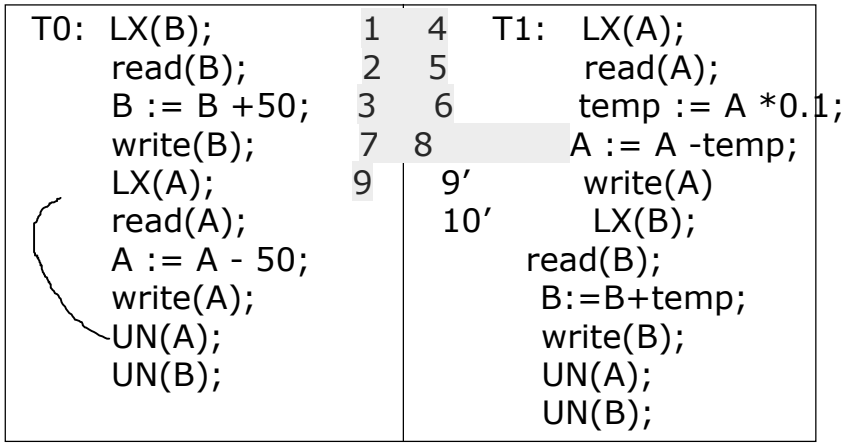
4.3. Lock

- Example



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5. Isolation levels

```
Set isolation level  <level>
```

- Read Uncommitted (No lost update)
  - Exclusive locks for write operations are held for the duration of the transactions
  - No locks for read
- Read Committed (No inconsistent retrieval)
  - Shared locks are released as soon as the read operation terminates.
- Repeatable Read (no unrepeatable reads)
  - Strict two phase locking
- Serializable (no phantoms)
  - Table locking or index locking to avoid phantoms

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Summary

- Transaction
  - Sequence of actions
- ACID
  - Properties of a transaction
- Concurrence control
  - Mechanism allows multiple transactions accessing the same resource in the same time
- Isolation level
  - Defining the level DBMS must ensure data integrity and correctness in processing concurrent accesses

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