



# HA NOI UNIVERSITY OF SCIENCE AND TECHNOLOGY
# SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGY


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# Lesson10
# Transaction Management

## Concurrence Control

# Learning objectives

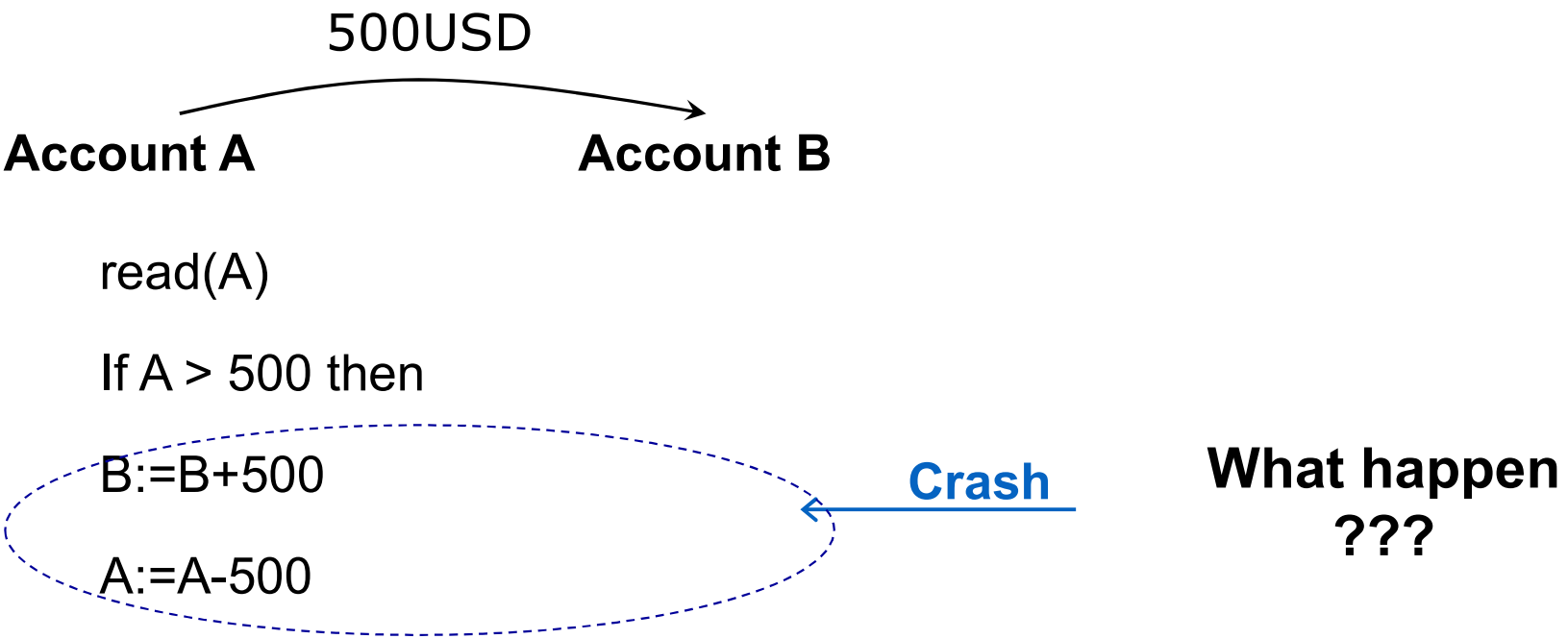
- ***Upon completion of this lesson, students will be able to:***

1. Understand main concepts of transaction
2. Be able to select a suitable transaction management strategy

# Outline

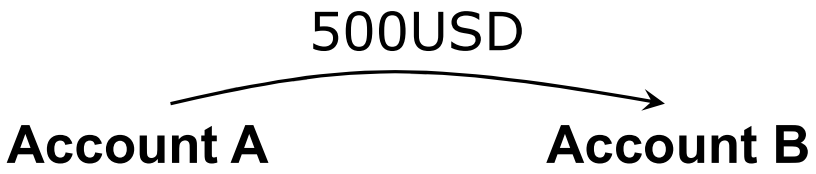
1. Transaction
2. ACID properties
3. Transaction Management Interface
4. Concurrence control
5. Isolation levels

# Example


500USD
Account A
Account B
read(A)
If A > 500 then
B:=B+500
A:=A-500
Crash
What happen
???

# 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

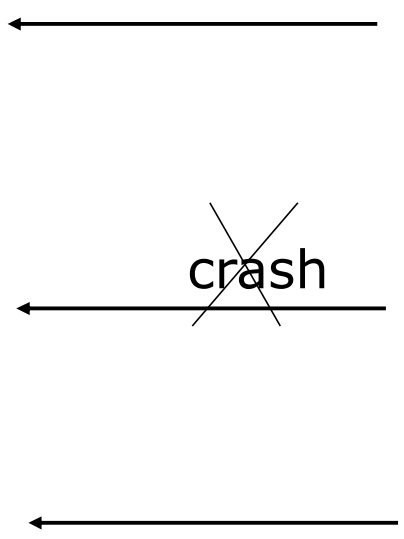
# 2. ACID Properties

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

# 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);
   }
```



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

# 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);
    t1:=t1-500;
    Write(A,t1);
   }
```

← *T': A+B (= 5000+3500)*

← *(A+B = 4500+3500)*

# 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);
   }
```

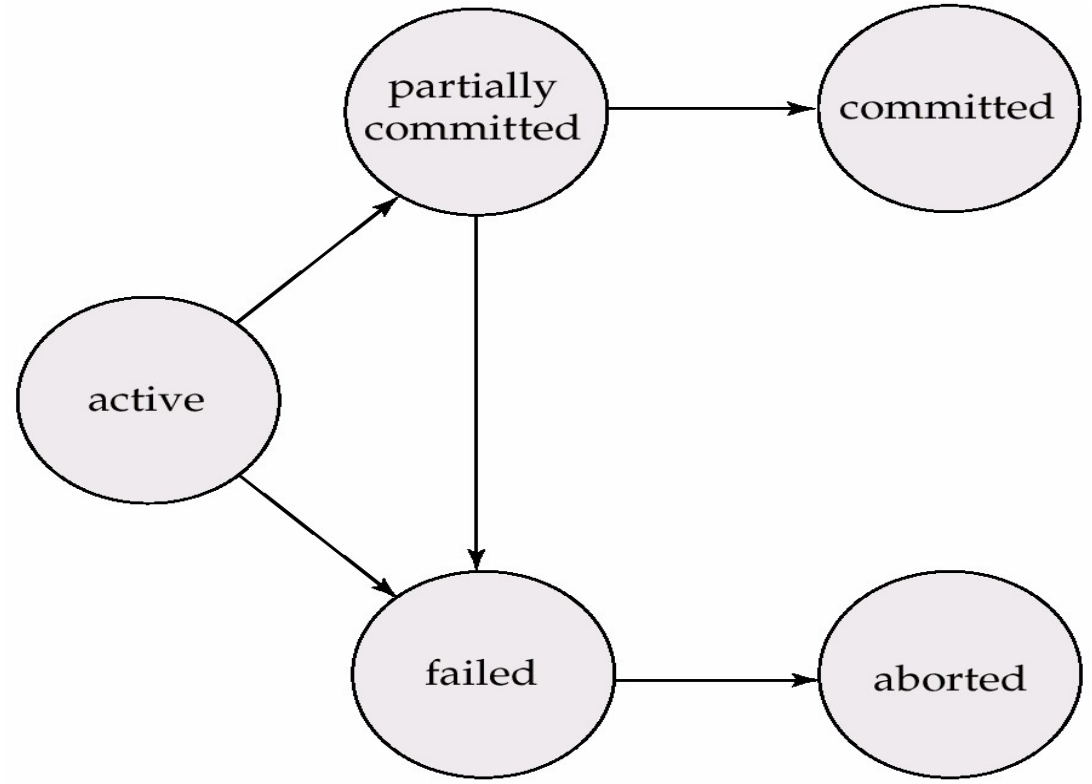
crash

A= 4500, B=3500

# 3. Transaction Management Interface

# 3.1. Transaction States

- Active
- Failed
- Aborted
- Commited
- Partially commited



# 3.1. Transaction States

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

  (savepoint = 0 ==> Abort)

# 4. Concurrent control

4.1. Objective

4.2. Scheduling

4.3. Lock

# 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);
     A := A -50;
     write(A);
     read(B);
     B := B + 50;
     write(B);
```

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

# 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)

# 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

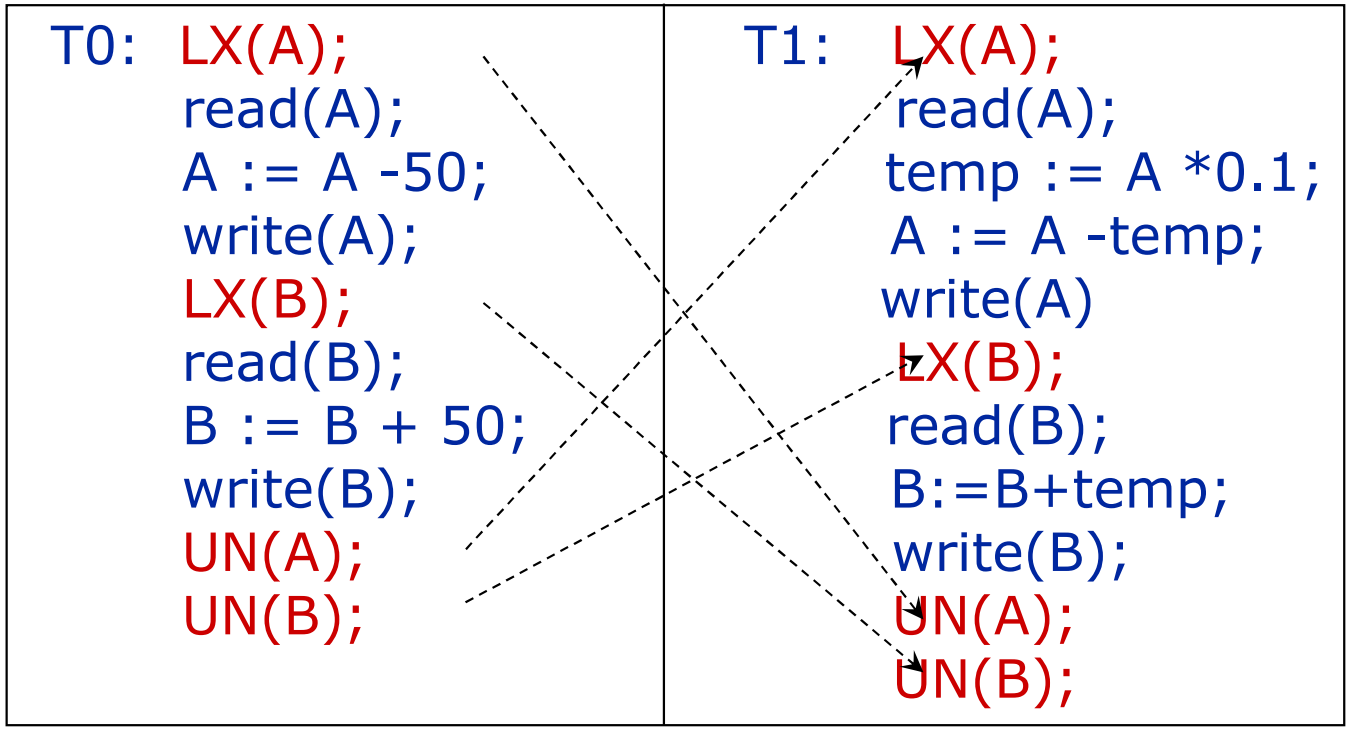
# 4.3. Lock

- 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 |

# 4.3. Lock

- Example



# 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

# 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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