Database Transactions – Part 1

Introduction

Transaction – A Classical Example

- **Scenario:** Suppose that Steve's account balance is **$1000** and Bob's balance is **$200**. Now Steve wants to transfer **$500** into Bob's account.
- There are several steps involved in transferring the money:
  1. **Check** Steve's balance;
  2. **Update** Steve's balance;
  3. **Check** Bob's balance;
  4. **Update** Bob's balance.
- Steve later checked his balance (it was **$500**), which looked good to Steve. However, Bob told Steve that he hadn't received his money yet (still **$200** in Bob's account instead of **$700**).

  Question: What did happen?

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Transaction – A Classical Example

- **Reason:** Due to power outage, the system **stopped working just after updating** Steve's balance.
- **Task:** Transfer **$500** from Steve's account to Bob's account

1.
```
SELECT balance FROM ACCOUNT
WHERE name = 'Steve';
```
2.
```
UPDATE ACCOUNT
SET balance = balance-500
WHERE name='Steve';
```
3.
```
SELECT balance FROM ACCOUNT
WHERE name = 'Bob';
```
4.
```
UPDATE ACCOUNT
SET balance = balance+500
WHERE name = 'Bob';
```

Operations	Steve	Bob
before 1	$1000	$200
after 1	$1000	$200
after 2	$500	$200
after 3	$500	$200
after 4	$500	$700

Transaction – A Classical Example

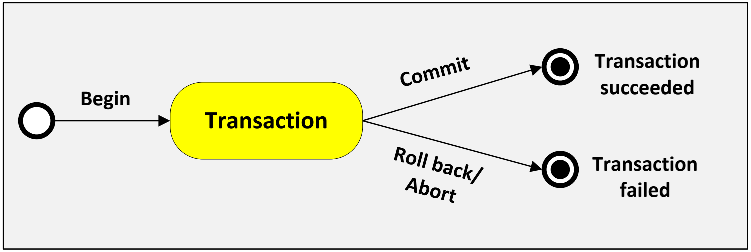
- We need an approach to ensure that
  - either the balances of Steve and Bob remain unchanged **if the money transfer fails**
  - or Steve's balance is **$500** and Bob's is **$700** **if the money transfer succeeds.**

1.
```
SELECT balance FROM ACCOUNT
WHERE name = ‘Steve’;
```
2.
```
UPDATE ACCOUNT
SET balance = balance-500
WHERE name=‘Steve’;
```
3.
```
SELECT balance FROM ACCOUNT
WHERE name = ‘Bob’;
```
4.
```
UPDATE ACCOUNT
SET balance = balance+500
```

Operations	Steve	Bob
before 1	$1000	$200
after 1	$1000	$200
after 2	$500	$200
after 3	$500	$200
after 4	$500	$700

What is a Transaction?

- DBMSs provide **transaction support** for solving this kind of problem.
- A **transaction** is **a sequence of database operations grouped together** for execution as **a logic unit** in a DBMS.
    - Different from an execution of a program outside the DBMS (e.g., a C program) in many ways!



What is a Transaction?

- Database applications often access a database **by transactions** rather than individual operations.
  - e.g., large databases and hundreds of concurrent users: banking, supermarket checkout, airline reservation, online purchasing, etc.
- **Why transactions?** They can **enforce data integrity** in the following situations:
  - multiple users may modify and share data at the same time;
  - transaction, system, and media failures may happen from time to time.
- **What does a transaction look like?**
  - `INSERT`, `SELECT`, `UPDATE`, `DELETE`, `BEGIN`, `COMMIT`, `ABORT` (`ROLLBACK`), etc. from a high-level language perspective;
  - `read`, `write`, `begin`, `commit`, `abort` at the internal process level.

Transaction – Language Level

- **Database operations** of a transaction (at the SQL language level) may include: `SELECT`, `INSERT`, `UPDATE`, `DELETE`.
- **Other operations**: `BEGIN`, `COMMIT`, `ABORT` (`ROLLBACK`)

```
    BEGIN TRANSACTION
1   SELECT balance FROM ACCOUNT WHERE name = ‘Steve’;
2   UPDATE ACCOUNT
    SET balance = balance-500 WHERE name=‘Steve’;
3   SELECT balance FROM ACCOUNT WHERE name = ‘Bob’;
4   UPDATE ACCOUNT
    SET balance = balance+500 WHERE name = ‘Bob’;
    COMMIT
```

Transactions - Internal Process Level

- **Basic operations** of a transaction (at the internal process level) are
  - `read(X)`: loads object X into main memory;
  - `write(X)`: modifies in-memory copy of object X (and writes it to disk later on);
- **Granularity of objects**: tables, rows, cells, or memory pages,
- **Other operations:**
  - `begin`: marks the beginning of a transaction;
  - `commit`: signals a successful end of the transaction - all changes can safely be applied to the database permanently;
  - `abort`: signals the transaction has ended unsuccessfully - undo all operations of the transaction.

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Transactions - Internal Process Level

```
T: BEGIN TRANSACTION
T: SELECT balance FROM ACCOUNT WHERE name = 'Steve';
T: UPDATE ACCOUNT SET balance = balance-500 WHERE name='Steve';
T: SELECT balance FROM ACCOUNT WHERE name = 'Bob';
T: UPDATE ACCOUNT SET balance = balance+500 WHERE name = 'Bob';
T: COMMIT;
```

Objects:

- A - Steve's account balance;
- B - Bob's account balance.

Steps	*T*
1	read(A)
2	write(A) (A:=A-500)
3	read(B)
4	write(B) (B:=B+500)
5	commit