

SQL: Transactions

CPS 116

Introduction to Database Systems

Announcements

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- ❖ Homework #2 due next Tuesday (Sept. 28)
- ❖ Project milestone #1 due next Thursday
- ❖ Discussion session this week (Homework #2 Q&A)
 - Time and place will be announced via email

Transactions

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- ❖ A transaction is a sequence of database operations with the following properties (ACID):
 - Atomic: Operations of a transaction are executed all-or-nothing, and are never left "half-done"
 - Consistency: Assume all database constraints are satisfied at the start of a transaction, they should remain satisfied at the end of the transaction
 - Isolation: Transactions must behave as if they were executed in complete isolation from each other
 - Durability: If the DBMS crashes after a transaction commits, all effects of the transaction must remain in the database when DBMS comes back up

SQL transactions

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- ❖ A transaction is automatically started when a user executes an SQL statement
- ❖ Subsequent statements in the same session are executed as part of this transaction
 - Statements see changes made by earlier ones in the same transaction
 - Statements in other concurrently running transactions do not see these changes
- ❖ COMMIT command commits the transaction
 - Its effects are made final and visible to subsequent transactions
- ❖ ROLLBACK command aborts the transaction
 - Its effects are undone

Fine prints

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- ❖ Schema operations (e.g., CREATE TABLE) implicitly commit the current transaction
 - Because it is often difficult to undo a schema operation
- ❖ Sometime you need to turn off a feature called AUTOCOMMIT, which automatically commits every single statement
 - Example: Run DB2's db2 command-line processor with the option +c
 - More examples to come when we cover database API's

Atomicity

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- ❖ Partial effects of a transaction must be undone when
 - User explicitly aborts the transaction using ROLLBACK
 - E.g., application asks for user confirmation in the last step and issues COMMIT or ROLLBACK depending on the response
 - The DBMS crashes before a transaction commits
- ❖ Partial effects of a modification statement must be undone when any constraint is violated
 - However, only this statement is rolled back; the transaction continues
- ❖ How is atomicity achieved?
 - Logging (to support undo)

Durability

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- ❖ Effects of committed transactions must survive DBMS crashes
- ❖ How is durability achieved?

Consistency

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- ❖ Consistency of the database is guaranteed by constraints and triggers declared in the database and/or transactions themselves
 - Whenever inconsistency arises, abort the statement or transaction, or (with deferred constraint checking or application-enforced constraints) fix the inconsistency within the transaction

Isolation

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- ❖ Transactions must appear to be executed in a serial schedule (with no interleaving operations)
- ❖ For performance, DBMS executes transactions using a serializable schedule
 - In this schedule, operations from different transactions can interleave and execute concurrently
 - But the schedule is guaranteed to produce the same effects as a serial schedule
- ❖ How is isolation achieved?
 - Locking, multi-version concurrency control, etc.

SQL isolation levels

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- ❖ Strongest isolation level: **SERIALIZABLE**
 - Complete isolation
 - SQL default
- ❖ Weaker isolation levels: **REPEATABLE READ, READ COMMITTED, READ UNCOMMITTED**
 - Increase performance by eliminating overhead and allowing higher degrees of concurrency
 - Trade-off: sometimes you get the “wrong” answer

READ UNCOMMITTED

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- ❖ Can read “dirty” data
 - A data item is dirty if it is written by an uncommitted transaction
- ❖ Problem: What if the transaction that wrote the dirty data eventually aborts?
- ❖ Example: wrong average
 - -- T1:
UPDATE Student
SET GPA = 3.0
WHERE SID = 142;

ROLLBACK;
 - -- T2:

SELECT AVG(GPA)
FROM Student;

COMMIT;

READ COMMITTED

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- ❖ No dirty reads, but non-repeatable reads possible
 - Reading the same data item twice can produce different results
- ❖ Example: different averages
 - -- T1:

UPDATE Student
SET GPA = 3.0
WHERE SID = 142;
COMMIT;
 - -- T2:
SELECT AVG(GPA)
FROM Student;

SELECT AVG(GPA)
FROM Student;
COMMIT;

REPEATABLE READ

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❖ Reads are repeatable, but may see phantoms

❖ Example: different average (still!)

```

-- T1:
INSERT INTO Student
VALUES(789, 'Nelson', 10, 1.0);
COMMIT;

-- T2:
SELECT AVG(GPA)
FROM Student;
COMMIT;
```

Summary of SQL isolation levels

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Isolation level/anomaly	Dirty reads	Non-repeatable reads	Phantoms
READ UNCOMMITTED	Possible	Possible	Possible
READ COMMITTED	Impossible	Possible	Possible
REPEATABLE READ	Impossible	Impossible	Possible
SERIALIZABLE	Impossible	Impossible	Impossible

❖ Syntax: At the beginning of a transaction,
`SET TRANSACTION ISOLATION LEVEL
isolation_level [READ ONLY|READ WRITE];`

- READ UNCOMMITTED can only be READ ONLY
