

## Announcements (September 26)

- Homework #2 due this Thursday
- Help session tomorrow (Wednesday) at 5:30pm in D344
- If you missed Homework #1 sample solution, pick one up from the handout box outside my office
- Project milestone #1 due in 2 ½ weeks
  - Come to my office hours if you want to chat about project ideas
- Midterm in class next Thursday (October 5)
  - A sample midterm will be available Thursday

#### Transactions

- A transaction is a sequence of database operations with the following properties (ACID):
  - Atomic: Operations of a transaction are executed all-ornothing, 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

- 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
- $\boldsymbol{\diamond}$  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

- Schema operations (e.g., CREATE TABLE) implicitly commit the current transaction
  - Because it is often difficult to undo a schema operation
- Many DBMS support an AUTOCOMMIT feature, which automatically commits every single statement
  - For DB2:
    - db2 command-line processor turns it on by default
    - You can turn it off with option +C
  - More examples to come when we cover database API's

## Atomicity

- \* Partial effects of a transaction must be undone when
  - User explicitly aborts the transaction using ROLLBACK
    - $\bullet$  E.g., application asks for user confirmation in the last step and issues <code>COMMIT</code> or <code>ROLLBACK</code> 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

- Effects of committed transactions must survive DBMS crashes
- \* How is durability achieved?
  - Forcing all changes to disk at the end of every transaction?
  - Logging (to support redo)

## Consistency

- 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

- 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

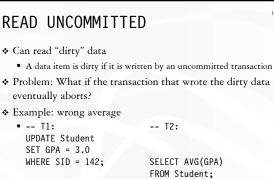
- Strongest isolation level: SERIALIZABLE
  - Complete isolation
  - SQL default
- Weaker isolation levels: REPEATABLE READ, READ COMMITTED, READ UNCOMMITTED

10

11

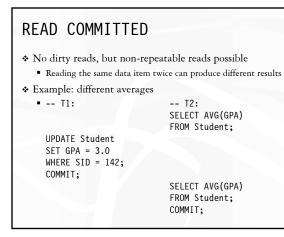
12

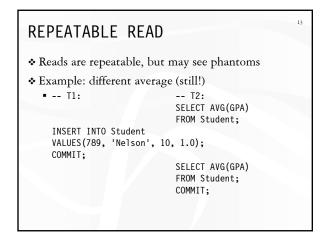
- Increase performance by eliminating overhead and allowing higher degrees of concurrency
- Trade-off: sometimes you get the "wrong" answer



ROLLBACK;

FROM Stude





Summary of SQL isolation levels				14
	Isolation level/anomaly	Dirty reads	Non-repeatable reads	Phantoms
	READ UNCOMMITTED	Possible	Possible	Possible
	READ COMMITTED	Impossible	Possible	Possible
	REPEATABLE READ	Impossible	Impossible	Possible

Impossible Impossible

14

Impossible

Syntax: At the beginning of a transaction, SET TRANSACTION ISOLATION LEVEL isolation\_level [READ ONLY | READ WRITE];

SERIALIZABLE

• READ UNCOMMITTED can only be READ ONLY