ACID Properties

by Sophia

WHAT'S COVERED

This lesson explores the ACID (atomicity, consistency, isolation, and durability) properties and how they affect database transactions, in two parts. Specifically, this lesson will cover:

1. Why ACID Properties Are Essential
2. ACID Properties

1. Why ACID Properties Are Essential

As we covered in the prior lesson, a transaction is a single unit of work that has to be fully executed or completely aborted if there are any issues within the transaction. There are no states between the beginning and end that are acceptable for a database to be in.

EXAMPLE James made a purchase of $500 for a computer from a store. All of the SQL statements that we defined in that transaction must be executed entirely:

```
BEGIN;
UPDATE customer_account
SET balance = balance - 500
WHERE account_id = 1000;
UPDATE store_inventory
SET quantity = quantity - 1
WHERE store_id = 5 AND product_name = 'Computer';
INSERT INTO customer_order(account_id, product_name,store_id, quantity,cost)
VALUES (1000, 'Computer',5, 1, 500);
UPDATE store_account
SET balance = balance + 500
WHERE store_id = 5;
COMMIT;
```

It is not acceptable to only deduct the purchase amount from James's account or remove inventory from the store. If any of the SQL statements in the transaction fail, the entire transaction is rolled back (i.e., not

committed) to the original state. If the transaction is successful, the changes to the database bring it from one consistent state to another. A **consistent state** is a state in which all of the data integrity constraints on the database are satisfied. ACID properties ensure that a consistent state always exists, even when system failures or power outages occur.

TERM TO KNOW

Consistent State

A state in which all of the data integrity constraints on the database are satisfied.

2. ACID Properties

To ensure that we have consistency in the database, every transaction has to begin with the database in a known consistent state. If the database is not in a consistent state, transactions can result in an inconsistent database due to violations of integrity or business rules. As such, all transactions in the database are controlled and executed to ensure integrity according to the **ACID** properties: atomicity, consistency, isolation, and durability.

Atomicity requires that all SQL statements of a transaction be completed. The transaction should be viewed as an indivisible logical unit of work. The entire transaction should be aborted if any of the SQL statements are not completed. For example, in our transaction above, imagine that the first two statements executed:

```
UPDATE customer_account
SET balance = balance – 500
WHERE account_id = 1000;
UPDATE store_inventory
SET quantity = quantity – 1
WHERE store_id = 5 AND product_name = ‘Computer’;
```

Then imagine that we ran into an error with the data that stopped the transaction. The entire transaction should be reverted to its original state. However, if all four statements in the transaction are executed successfully, the entire transaction will be committed to the database.

Consistency ensures that the database is in a consistent state. This means that a transaction takes a database from one consistent state to another. When a transaction starts, the database must be in a consistent state; when the transaction ends, the database must be in a consistent state. If any of the parts of the transaction violate one of the integrity constraints, the entire transaction is aborted.

Isolation means that the data that is used during the first transaction cannot be used in another transaction until the first transaction has finished executing. In looking at the example above, imagine that James and another customer purchased a computer at similar times. If James's transaction has started, the second customer cannot attempt to purchase the same computer until James’s transaction is completed. Otherwise, they may have both tried to purchase the single available computer. This is especially important for multiuser databases, where there will be many users accessing and updating the database at the same time.

Durability is the last ACID property. It ensures that when the transaction changes are finished and committed, they cannot be undone or removed, even if there is a system failure.

We will discuss each of these properties in further detail in the upcoming lessons.

TERMS TO KNOW

ACID

An acronym for the four properties that ensure data validity: Atomicity, Consistency, Isolation, and Durability. Transactions are database operations that satisfy the ACID properties.

Atomicity

The quality of being indivisible.

Consistency

The quality of something being done the same way in all cases.

Isolation

The quality of being inaccessible until certain conditions are met.

Durability

The quality of continuing to exist without being undone or removed.

SUMMARY

In this lesson, you learned that **why ACID properties (Atomicity, Consistency, Isolation, Durability) are essential** for keeping database transactions consistent and reliable. Transaction consistency, an ACID property, ensures data integrity and defined rules are adhered to while transitioning from one state to another. Each transaction leaves the database in a state consistent with the application's business logic, constraints, and integrity requirements.

Data consistency prevents transactions from violating constraints or business rules. Databases maintain consistency through mechanisms such as validation checks, triggers, and constraints. For example, a bank's database might need to validate that an account has the funds to cover a withdrawal before processing that withdrawal, and if it does not, the entire withdrawal transaction is canceled. You also learned that the **ACID properties**, when implemented together, ensure consistent database operation even when unexpected errors or system failures occur. Because consistency is an integral part of ACID principles, the data stored within the system will be reliable and trustworthy.

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