Fun with Transactions

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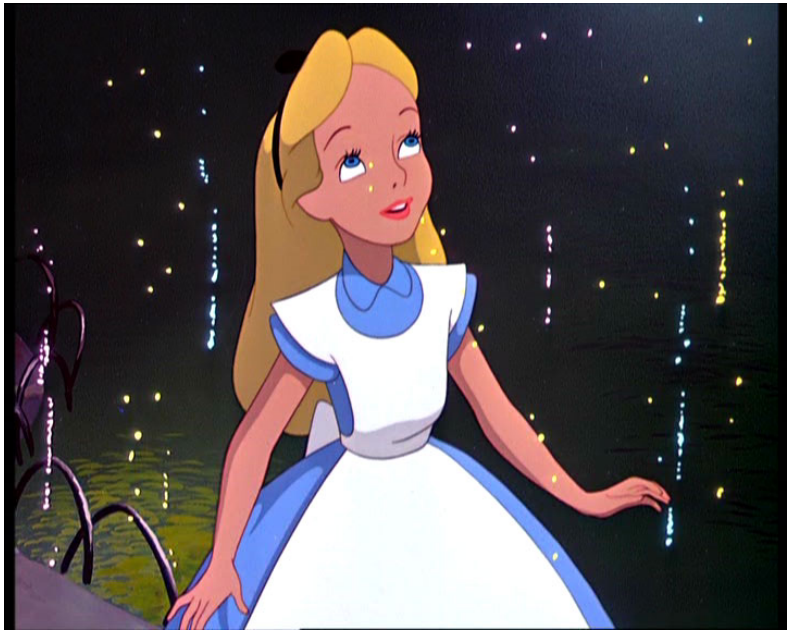
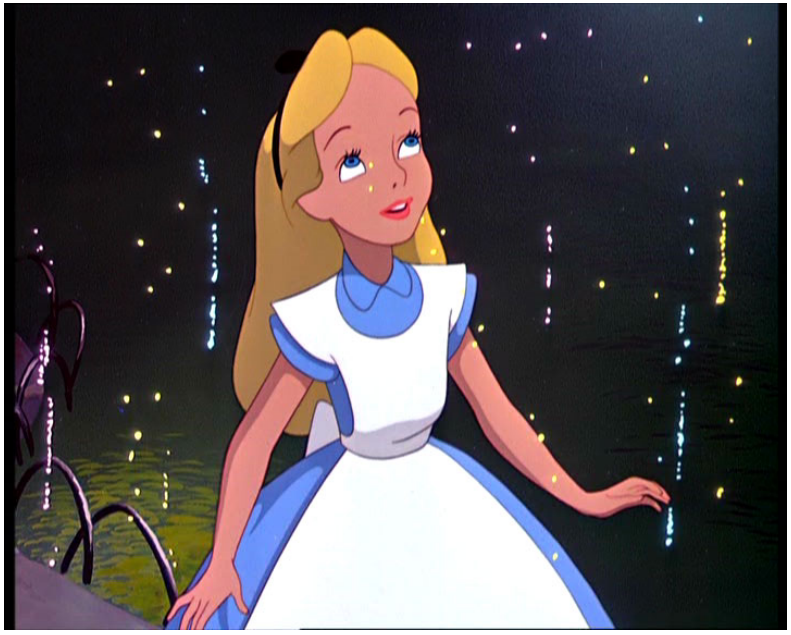
First, an illustration...

An illustration

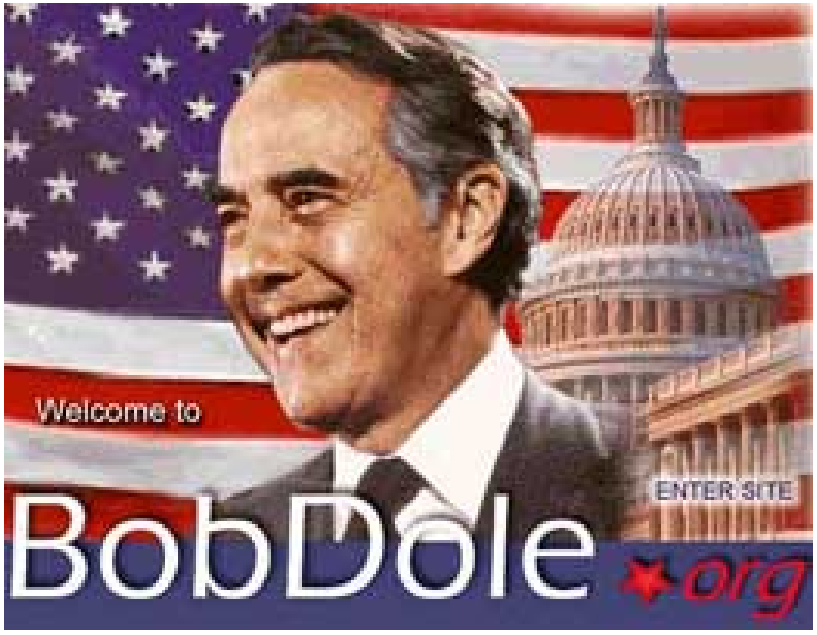


Alice

An illustration

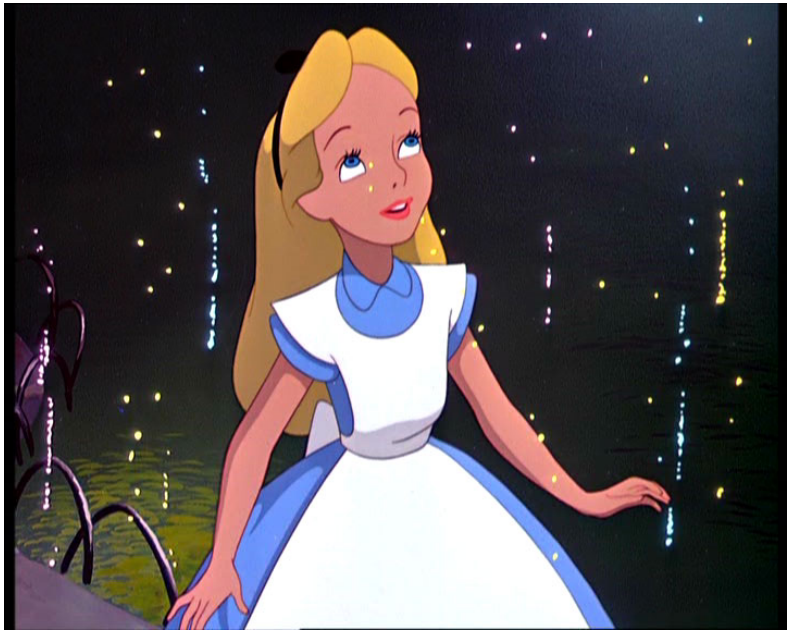


Alice

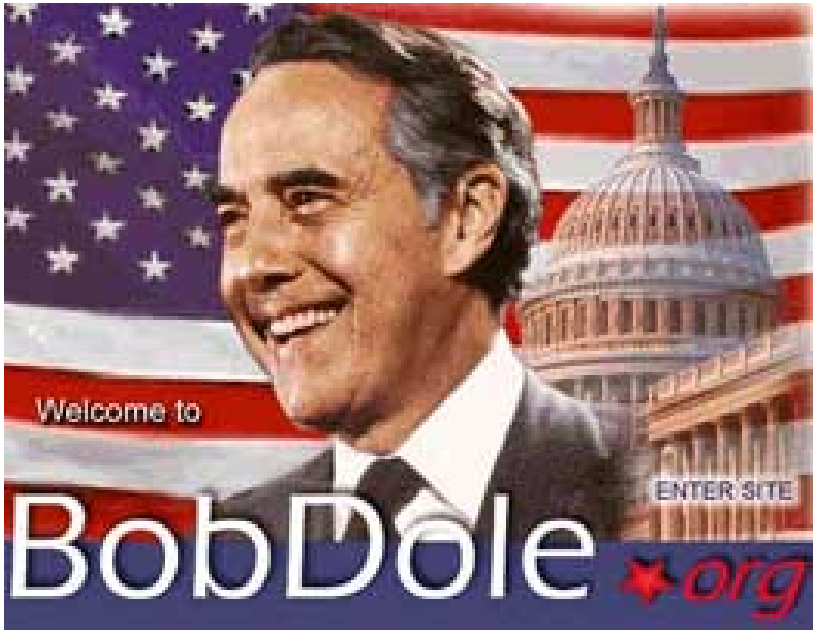


Bob

An illustration



Alice



Bob

Alice wants to donate $25 to Bob's campaign

An illustration

Alice gives Bob a check for $25 dollars from East Podunk Savings and Loan

East Podunk Savings and Loan

An illustration

1. Take Alice's check from the pile of checks
2. Debit Alice $25
3. Credit Bob $25
4. Mark check as processed
5. Return check to Alice

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What happens when the server crashes?

Atomicity

Database designers wanted to specify groups of operations, and have them succeed or fail as a group. This is called **atomicity**.
This gave rise to an API:

- **BEGIN** – Indicate the beginning of a group of operations. These groups are called "transactions"
- **COMMIT** – Perform the operations as an atomic group. It is possible at this point for the commands to fail, and for COMMIT to return an error
- **ROLLBACK** – End this group, and undo the operations of this group

ACID

Further research developed a list of four characteristics users wanted their transactions to have, which were given the acronym **ACID**:

- **Atomicity** – Groups of operations all either succeed or fail, as a group
- **Consistency** – Users can define constraints on the data. After a transaction finishes, the data set meets each of those constraints.
- **Isolation** – Users can see data only from committed transactions. No one sees my data until I commit it. More on this later
- **Durability** – Once committed, data remain committed, even if the server crashes.

NoSQL?

In recent years, database users have begun to question the universal application of ACID, such as with the NoSQL movement.

- This is not a bad thing
- Many applications don't need traditional transactions
- Many more applications *do* require traditional transactions, but don't realize it, or are using them incorrectly

True or False: I'm not a bank. Therefore, I don't need tranasctions.

True or False: I'm not a bank. Therefore, I don't need tranasctions.

False

More examples

One End Point client manages call center data. Their application includes tasks like these:

- Update notes for a support case
- Modify employee performance statistics as technicians take calls
- Update training databases for calls "randomly recorded for training purposes"
- Bill customers for support costs

Failures within any of these operations without transactional guarantees will lead to orphaned records, missing information, and irritated customers.

More examples

TriSano™(http://www.trisano.org) is a public health reporting application built by an End Point client. For each new case, the application can record some or all of the following:

- Patient demographics
- Participating physicians
- Laboratory tests
- Reports to various agencies
- Contacts of different types
- Custom data collection forms

These data live in many different tables. Changes need to be atomic to prevent orphaned data and ensure consistency.

ORMs

Object-Relational Mappers (ORMs) often provide APIs for transaction control. Users generally ignore those APIs, and let the ORM follow its default behavior. This behavior is generally wrong.

Transactions are designed to group operations. Only the programmer knows what groups make the most sense. Therefore, the programmer (not the ORM, the database system, the database driver, or anything else) shold define operation groupings.

- You probably need transactions whether you're ready to admit it or not
- You probably need transactions whether you're ready to write your software to handle it or not
- The application has units of work it needs to keep atomic
- Only the application knows the boundaries of those units
- Unfortunately often your ORM disagrees with these last two

Neat Transaction Tricks

Savepoints

Transactions group operations. Within those groups, there may be nested subgroups, called subtransactions, implemented with **savepoints**.

Savepoint Example

```
BEGIN;
-- Do something useful
INSERT INTO actions VALUES
   ('IM IN YR AKSHUNZ DOIN YOOSFL STUFS');
SAVEPOINT try_something;
SELECT COUNT(*) FROM some_other_table;
UPDATE foo SET bar = baz WHERE qux = 42;
-- Perhaps a constraint causes a failure here
ROLLBACK TO SAVEPOINT try_something;
-- My outer transaction is still in-flight
```

Implementation note

In PostgreSQL, a statement that generates an error will cause continued errors until a rollback, either to a savepoint or of the transaction entirely. This makes savepoints quite common:

```
josh=# BEGIN;
BEGIN
josh=# SELECT syntax error;
ERROR: syntax error at or near "error"
LINE 1:  SELECT syntax error;
josh=# SELECT 1;
ERROR: current transaction is aborted, commands
ignored until end of transaction block
josh=# ROLLBACK;
```

Implementation note

MySQL, on the other hand, returns an error message for the syntax error, but still allows the transaction to commit:

```
mysql> start transaction;
mysql> insert into i values (1);
mysql> insert into i values (2);
mysql> insert into i values (1);
ERROR 1062 (23000):  Duplicate entry '1' for key 1
mysql> insert into i values (3);
mysql> commit;
Query OK, 0 rows affected (0.00 sec)
```

Implementation note

Your mileage may vary. Test, and pay attention to return results and error messages

Isolation levels

Isolation means I can't see values from transaction that's not committed unless it's my own. There are three phenomena it relates to:

- **Dirty read**: A transaction reads data from a concurrent uncommitted transaction
- **Nonrepeatable read**: A transaction re-reads data and finds another transaction has changed them
- **Phantom read**: A transaction re-executes a query, and the set of rows satisfying that query has changed due to some other transaction.

Isolation levels

The SQL standard defines four isolation levels in terms of these phenomena:

Isolation Level	**Dirty**	**Non-repeat**	**Phantom**
Read uncommitted	Yes	Yes	Yes
Read committed	No	Yes	Yes
Repeatable read	No	No	Yes
Serializable	No	No	No

Applications can choose an isolation level appropriate for their needs. Stricter levels will possible entail poorer performance.

Beyond the database

A transaction is an atomically committed group of operations. This idea is not limited to databases. Some other examples:

- Message queues
- Integration software
- Transactional memory systems

Message queues