SQL: Data Definition Language

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Database Schemas in SQL

SQL is primarily a query language, for getting information from a database.

- DML: Data Manipulation Language

But SQL also includes a *data-definition* component for describing database schemas.

- DDL: Data Definition Language

Creating (Declaring) a Relation

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Simply:

- CREATE TABLE <table_name> (
  <list of elements>
  );

Deleting a relation:

- DROP TABLE <table_name>;

Elements of Table Declarations

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Most basic element: an attribute and its type.

Common Types:

- INT or INTEGER (synonyms).
  - Also: SMALLINT, MEDIUMINT, and BIGINT
- REAL or FLOAT or DOUBLE (synonyms).
- CHAR(*n*) = fixed-length string of *n* characters.
- VARCHAR(*n*) = variable-length string of up to *n* characters.

Additional data type found here:
https://dev.mysql.com/doc/refman/5.7/en/data-types.html

Example: Create Table

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```
CREATE TABLE Sells (
        bar     CHAR(20),
        beer    VARCHAR(20),
        price   REAL
);
```

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SQL Values

Integers and reals are represented as you would expect.

Strings are too, except they require single quotes.

- Two single quotes = real quote

  e.g. 'Joe''s Bar'.

Any value can be NULL

- Unless attribute has NOT NULL constraint

  e.g. price REAL not null,

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Dates and Times

DATE and TIME are types in SQL

- MySQL even has DATETIME
  - Ranging from 1000-01-01 00:00:00 to 9999-12-31 23:59:59

The form of a date value is:

DATE ‘yyyy-mm-dd’

e.g. DATE ‘2007-09-30’ is September 30th, 2007.

Times and Values

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The form of a time value is:

- TIME ‘hh:mm:ss’ – with an optional decimal point for a fraction of a second.

e.g. TIME ‘15:30:02.5’ = two and a half seconds after 3:30pm.

Declaring Keys

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An attribute or list of attributes may be declared PRIMARY KEY or UNIQUE.

Either says that no two tuples of the relation may agree in all the attribute(s) on the list.

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Example

Beers (<u>name</u>, manf)
Bars (<u>name</u>, addr, license)
Drinkers (<u>name</u>, addr, phone)
Likes (<u>drinker</u>, <u>beer</u>)
Sells (<u>bar</u>, <u>beer</u>, price)
Frequents (<u>drinker</u>, <u>bar</u>)

Underline = *key* (tuples cannot have the same value in all key attributes)

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Declaring Multi-Attribute Keys

A key declaration can also be another element in the list of elements of a CREATE TABLE statement.

This form is essential if the key consists of more than one attribute.

- Could be used for one-attribute keys.

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Example

The bar and beer together are the key for Sells:

```
CREATE TABLE Sells (
        bar     CHAR(20),
        beer    VARCHAR(20),
        price   REAL,
        PRIMARY KEY (bar, beer)
);
```

Declaring Single-Attribute Keys

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Place PRIMARY KEY or UNIQUE KEY after the type in the declaration of the attribute.

Example:

```
CREATE TABLE Beers  (
        name  CHAR(20)  UNIQUE,
        manf  CHAR(20)
);
```

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Primary Key vs. Unique

1. There can be only one PRIMARY KEY for a relation, but several UNIQUE attributes.

2. No attribute of a PRIMARY KEY can ever be NULL in any tuple. But attributes declared UNIQUE may have NULL's, and there may be several tuples with NULL.

Types of Constraints

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1. **Keys**
2. **Foreign-key** (referential-integrity) constraint
3. **Domain** constraint
   - Constrain values of a particular attribute.
4. **Tuple-based** constraint
   - Relationship among components.
5. **Assertions**: any SQL Boolean expressions

Foreign Keys

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Values appearing in attributes of one relation must appear together in certain attributes of another relation.

Example: in Sells(bar, beer, price), we might expect that a beer value also appears in Beers.name

Expressing Foreign Keys

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Use keyword REFERENCES, either:

1. After an attribute (for one-attribute keys).
2. As an element of the schema:

   FOREIGN KEY (<list of attributes>)

   REFERENCES <relation> (<attributes>)

Referenced attributes must be declared PRIMARY KEY or UNIQUE.

Example: with Attribute

```
CREATE TABLE Beers (
        name   CHAR(20)        PRIMARY KEY,
        manf   CHAR(20)
);
CREATE TABLE Sells (
        bar    CHAR(20),
        beer   CHAR(20)        REFERENCES   Beers(name),
        price  REAL
);
```

Example: As Schema Element

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```
CREATE TABLE Beers (
        name   CHAR(20)        PRIMARY KEY,

        manf   CHAR(20)

);

CREATE TABLE Sells (
        bar     CHAR(20),
        beer    CHAR(20),

        price   REAL

        FOREIGN KEY (beer)   REFERENCES   Beers(name)

);
```

Enforcing Foreign-Key Constraints

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If there is a foreign-key constraint from relation *R* to relation *S*, two violations are possible:

1. An insert or update to *R* introduces values not found in *S*.
2. A deletion or update to S causes some tuples of *R* to "dangle."

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Actions Taken

Example: suppose R = Sells, S = Beers.

An insert or update to **Sells** that introduces a nonexistent beer must be rejected.

A deletion or update to **Beers** that removes a beer value found in some tuples of **Sells** can be handled in three ways.

Actions Taken

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Default: Reject the modification.

Cascade: Make the same changes in Sells.

- Deleted beer: delete Sells tuple.
- Updated beer: change value in Sells.

Set Null: Change the beer to NULL.

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Reference Options

RESTRICT: rejects the delete or update operation for the parent table.

CASCADE: ON DELETE or ON UPDATE the row from the parent table, and automatically delete or update the matching rows in the child table.

SET NULL: delete or update the row from the parent table, and set the Foreign Key column(s) in the child table to NULL.

NO ACTION: equivalent to RESTRICT.

More details found in the MySQL Reference Manual.

Example: Cascade

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Delete the Bud tuple from Beers:

- Then delete all tuples from Sells that have beer = 'Bud'.

Update the Bud tuple by changing 'Bud' to 'Budweiser'

- Then change all Sells tuples with beer = 'Bud' to beer = 'Budweiser'

Example: Set NULL

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Delete the Bud tuple from Beers:

- Change all tuples of Sells that have beer = ‘Bud’ to have beer = NULL.

Update the Bud tuple by changing ‘Bud’ to ‘Budweiser’:

- Same change as for deletion.

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Example: Setting Policy

```
CREATE TABLE Sells (
        bar  CHAR(20),
        beer  CHAR(20),
        price  REAL,
        FOREIGN KEY(beer)
                REFERENCES Beers(name)
                ON DELETE SET NULL
                ON UPDATE CASCADE
);
```

Choosing a Policy

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When we declare a foreign key, we may choose policies SET NULL or CASCADE independently for deletions and updates.

Follow the foreign-key declaration by: ON [UPDATE, DELETE][SET NULL CASCADE]

Two such clauses may be used.

Otherwise, the default (reject) is used.

Attribute-Based Checks

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Constraints on the value of a particular attribute.

Add CHECK(<condition>) to the declaration for the attribute.

The condition may use the name of the attribute, but any other relation or attribute must be in a sub-query.

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Example: Attribute-Based Check

```
CREATE TABLE Sells (
        bar  CHAR(20),
        beer  CHAR(20)  CHECK (
                beer IN (SELECT name FROM Beers)),
        price  REAL  CHECK (price <= 5.00)
);
```

Timing of Checks

Attribute-based checks are performed only when a value for that attribute is inserted or updated.

- **Example:** CHECK (price <= 5.00) checks every new price and rejects the modification (for that tuple) if the price is more than $5.

- **Example:** CHECK (beer IN (SELECT name FROM Beers)) not checked if a beer is deleted from Beers (unlike foreign-keys).

Tuple-Based Checks

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CHECK (<condition>) may be added as a relation-schema element.

The condition may refer to any attribute of the relation.

- But other attributes or relations require a sub-query.

Checked on insert or update only.

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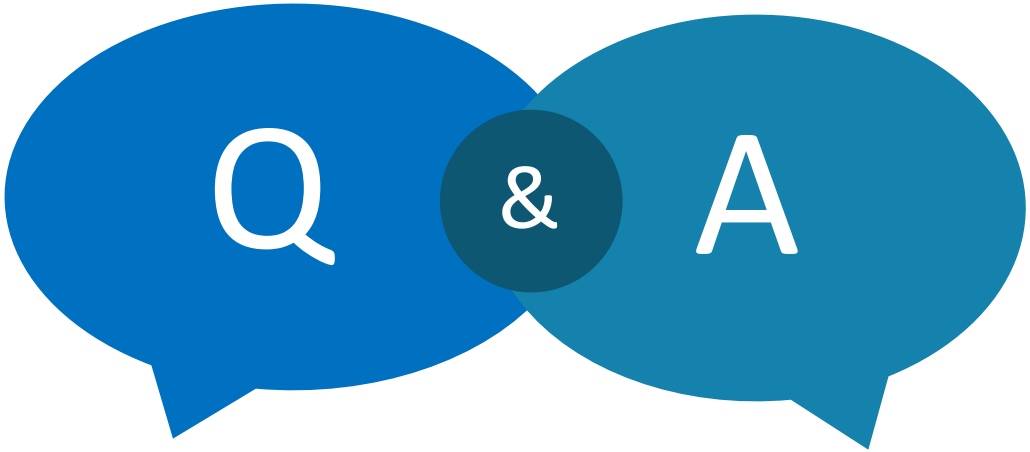
Example: Tuple-Based Check

- Only Joe's Bar can sell beer for more than $5.

```
CREATE TABLE Sells (
        bar     CHAR(20),
        beer    CHAR(20),
        price       REAL,
        CHECK (bar = 'Joe''s Bar' OR price <= 5.00)
);
```

Questions?



THANKS FOR LISTENING

I'LL BE ANSWERING QUESTIONS NOW

Citations, Images and Resources

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Database Management Systems (3rd Ed.), Ramakrishnan & Gehrke

Some content is based off the slides of Dr. Fei Chiang - http://www.cas.mcmaster.ca/~fchiang/

http://csharpcorner.mindcrackerinc.netdna-cdn.com/UploadFile/BlogImages/06112016031910AM/sql.png