PURDUE UNIVERSITY

CS54100: Database Systems

SQL DDL

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Defining a Database Schema

`CREATE TABLE` name (list of elements).

- Principal elements are attributes and their types, but key declarations and constraints also appear.
- Similar `CREATE` *X* commands for other schema elements *X*: views, indexes, assertions, triggers.
- "`DROP` *X* name" deletes the created element of kind *X* with that name.

Example

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

Constraints

Commercial relational systems allow much more "fine-tuning" of constraints than do the modeling languages we learned earlier.

- In essence: SQL programming is used to describe constraints.

Outline

1. Primary key declarations.
2. Foreign-keys = referential integrity constraints.
3. Attribute- and tuple-based checks = constraints within relations.
4. SQL Assertions = global constraints.
   - Not found in Oracle.
5. Oracle Triggers.
   - A substitute for assertions.

Declaring Keys

Use `PRIMARY KEY` or `UNIQUE`.

- But only one primary key, many `UNIQUE`s allowed.
- SQL permits implementations to create an *index* (data structure to speed access given a key value) in response to `PRIMARY KEY` only.
  - But PostgreSQL and Oracle create indexes for both.
- SQL does not allow nulls in primary key, but allows them in "unique" columns (which may have two or more nulls, but not repeated non-null values).

Declaring Keys

Two places to declare:

1. After an attribute's type, if the attribute is a key by itself.
2. As a separate element.
   - Essential if key is >1 attribute.

Example

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

Example

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

is different than:

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


Other Properties You Can Give to Attributes

1. `NOT NULL` = every tuple must have a real value for this attribute.
2. `DEFAULT` value = a value to use whenever no other value of this attribute is known.

Example

```
CREATE TABLE Drinkers (
 name CHAR(30) PRIMARY KEY,
 addr CHAR(50)
       DEFAULT '123 Sesame St',
 phone CHAR(16)
);
```

```
INSERT INTO Drinkers(name)
VALUES('Sally')
```

results in the following tuple:

name	addr	phone
Sally	123 Sesame St.	NULL

- Primary key is by default not NULL.
- This insert is legal.
  - OK to list a subset of the attributes and values for only this subset.
- But if we had declared

  ```
  phone CHAR(16) NOT NULL
  ```

  then the insertion could not be made.

Interesting Defaults

- DEFAULT CURRENT_TIMESTAMP
- SEQUENCE

```
CREATE SEQUENCE customer_seq;
CREATE TABLE Customer (
  customerID INTEGER
    DEFAULT
  nextval('customer_seq'),
  name VARCHAR(30)
);
```

Foreign Keys

In relation *R* a clause that "attribute *A* references *S*(*B*)" says that whatever values appear in the *A* column of *R* must also appear in the *B* column of relation *S*.

- *B* must be declared the primary key for *S*.

Example

```
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
);
```


Alternative: add another element declaring the foreign key, as:

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

- Extra element essential if the foreign key is more than one attribute.

What Happens When a Foreign Key Constraint is Violated?

- Two ways:

1. Insert or update a `Sells` tuple so it refers to a nonexistent beer.
   - Always rejected.
2. Delete or update a `Beers` tuple that has a `beer` value some `Sells` tuples refer to.
   a) Default: reject.
   b) *Cascade*: Ripple changes to referring `Sells` tuple.

Example

- Delete "Bud." Cascade deletes all `Sells` tuples that mention Bud.
- Update "Bud" to "Budweiser." Change all `Sells` tuples with "Bud" in `beer` column to be "Budweiser."

c) *Set Null*: Change referring tuples to have `NULL` in referring components.

Example

- Delete "Bud." Set-null makes all `Sells` tuples with "Bud" in the `beer` component have `NULL` there.
- Update "Bud" to "Budweiser." Same change.

Selecting a Policy

Add `ON [DELETE, UPDATE] [CASCADE, SET NULL]` to declaration of foreign key.

Example

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

- "Correct" policy is a design decision.
  - *E.g.*, what does it mean if a beer goes away? What if a beer changes its name?

Attribute-Based Checks

Follow an attribute by a condition that must hold for that attribute in each tuple of its relation.

- Form: `CHECK (`condition`)`.
  - Condition may involve the checked attribute.
  - Other attributes and relations may be involved, but *only* in subqueries.
  - Oracle: *No subqueries allowed in condition*.
- Condition is checked only when the associated attribute changes (*i.e.*, an insert or update occurs).

Example

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

- Check on `beer` is like a foreign-key constraint, except:
  - The check occurs only when we add a tuple or change the beer in an existing tuple, not when we delete a tuple from `Beers`.

Tuple-Based Checks

Separate element of table declaration.

- Form: like attribute-based check.
- But condition can refer to any attribute of the relation.
  - Or to other relations/attributes in subqueries.
  - Again: Oracle forbids the use of subqueries.
- Checked whenever a tuple is inserted or updated.

Example

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)
);
```


SQL Assertions

- Database-schema constraint.
- Not present in Oracle.
- Checked whenever a mentioned relation changes.
- Syntax:

  `CREATE ASSERTION` < name>

  `CHECK(`<condition>`);`

Example

No bar may charge an average of more than $5 for beer.

```
Sells(bar, beer, price)

CREATE ASSERTION NoRipoffBars
CHECK(NOT EXISTS(
        SELECT bar
        FROM Sells
        GROUP BY bar
        HAVING 5.0 < AVG(price)
        )
);
```

- Checked whenever `Sells` changes.

Example

There cannot be more bars than drinkers.

```
Bars(name, addr, license)
Drinkers(name, addr, phone)

CREATE ASSERTION FewBar
CHECK(
    (SELECT COUNT(*) FROM Bars) <=
    (SELECT COUNT(*) FROM Drinkers)
);
```

- Checked whenever `Bars` or `Drinkers` changes.

PURDUE UNIVERSITY

CS54100: Database Systems

SQL DDL, Views

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Types

1. `INT` or `INTEGER`.
2. `REAL` or `FLOAT`.
3. `CHAR(`*n*`)` = fixed length character string, padded with "pad characters."
4. `CHARACTER VARYING` (or `VARCHAR`) (*n*) = variable-length strings up to *n* characters.
5. `NUMERIC(`*precision, decimal*`)` is a number with *precision* digits with the decimal point *decimal* digits from the right. `NUMERIC(10,2)` can store ±99,999,999.99

Types

6. `DATE`. SQL form is `DATE 'yyyy-mm-dd'`
   - Oracle uses a different standard format
   - Use "Alter session" command to fix it
7. `TIME`. Form is `TIME 'hh:mm:ss[.ss…]'` in SQL.
8. `DATETIME` or `TIMESTAMP`. Form is `TIMESTAMP 'yyyy-mm-dd hh:mm:ss[.ss…]'` in SQL.
   - Generally preferable to just "Date" or "time"
   - Be careful with semantics of comparison
9. Various extensions
   - INTERVAL – time interval
   - BLOB, LONG, RAW – large objects with little typing

Changing Columns

Add an attribute of relation *R* with

`ALTER TABLE` *R* `ADD` <column declaration>`;`

Example

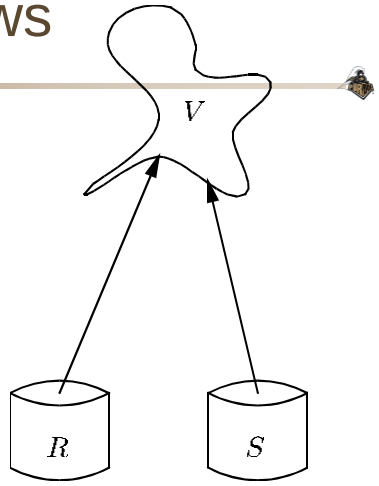
```
ALTER TABLE Bars ADD phone CHAR(16)
        DEFAULT 'unlisted';
```

- Columns may also be dropped.

```
ALTER TABLE Bars DROP license;
```

Views

An expression that describes a table without creating it.



- View definition form is:

```
CREATE VIEW <name> AS <query>;
```


Example

The view `CanDrink` is the set of drinker-beer pairs such that the drinker frequents at least one bar that serves the beer.

```
CREATE VIEW CanDrink AS
  SELECT drinker, beer
  FROM Frequents, Sells
  WHERE Frequents.bar = Sells.bar;
```

Querying Views

Treat the view as if it were a materialized relation.

Example

```
SELECT beer
FROM CanDrink
WHERE drinker = 'Sally';
```

Theory behind views

- Every relational query returns a relation
  - Possibly a single row, single column relation
- Query result could be stored in a table
  - Use in future queries
- View: Do this "on the fly"
  - Generate the result *every time the view is used*

Using Views

- Access control: Limit who sees data
- Different logical views
  - Schema migration
- "short cuts"

View Limitations

- Performance
  - Materialized views
- Update
  - Insert
  - Modify
  - Delete
- Solutions to come
  - Triggers

