CS 235: Introduction to Databases

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Lecture Notes #13

Outline

- Active elements
  - Maintain database integrity and consistency.
  - Part of database schema.
- Constraints

Constraints

- Restrictions on the data in your database.
- 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.

Constraint Types

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

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 (or unique) for *S*.
  - Why is this restriction necessary?

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 Declaration

- 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.
- *MySQL recognizes only this declaration*.

Foreign Keys in MySQL

- Both the referenced and referencing tables must be of type InnoDB.
  - Default type is MyISAM (indexed sequential access method)
- The FOREIGN KEY syntax must be used.
- In the referenced table, there must be an index on the referenced columns
  - PRIMARY KEY or UNIQUE create one automatically.

MySQL Example

```
CREATE TABLE Beers (
     name CHAR(20) PRIMARY KEY,
     manf CHAR(20)
) TYPE = InnoDB;

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

Foreign Key Constraint Violations

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 the modification.
   - *b) Cascade*: Ripple changes to referring *Sells* tuple.
   - *c) Set Null*: Change referring tuples to have NULL in referring components.

Example (Cascade)

- 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.

Example (Set-Null)

- Delete Bud.
- Set-null makes all Sells tuples with Bud in the beer component have NULL there.

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

Selecting a Policy

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

```
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.
- CHECK (condition).
  - Condition may involve the checked attribute.
  - Other attributes and relations may be involved, but *only* in subqueries.
  - MySQL: CHECK parsed but *ignored*.
- 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: MySQL parses but ignores checks.
- Checked whenever a tuple is inserted or updated.

Example

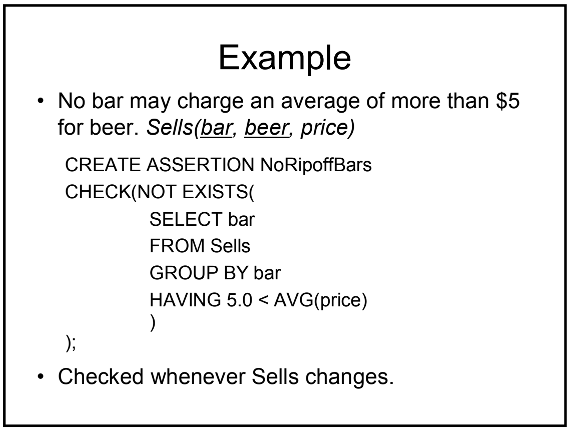
- Only Ripoff bar can sell beer for more than $10.

```
CREATE TABLE Sells (
     bar CHAR(20),
     beer CHAR(20),
     price REAL,
     CHECK(bar = 'Ripoff' OR
          price <= 10.00)
);
```

SQL Assertions

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

```
CREATE ASSERTION <name>
CHECK(<condition>);
```

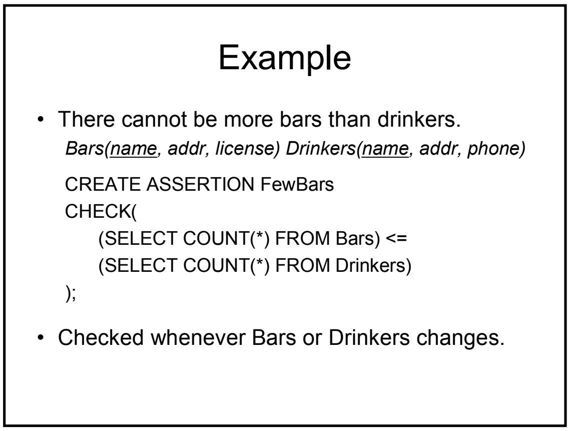


Example

- 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.

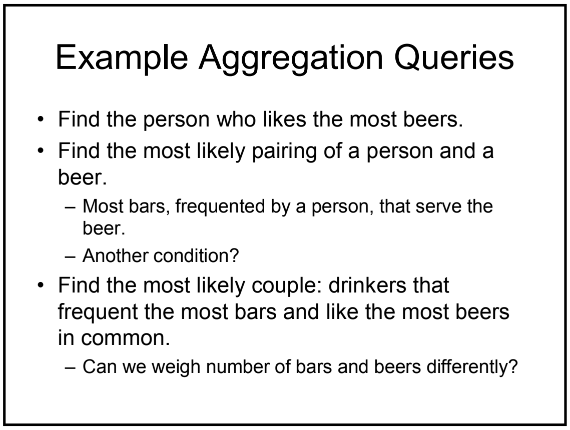


Example

- There cannot be more bars than drinkers.
  Bars(name, addr, license) Drinkers(name, addr, phone)

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

- Checked whenever Bars or Drinkers changes.



Example Aggregation Queries

- Find the person who likes the most beers.
- Find the most likely pairing of a person and a beer.
  - Most bars, frequented by a person, that serve the beer.
  - Another condition?
- Find the most likely couple: drinkers that frequent the most bars and like the most beers in common.
  - Can we weigh number of bars and beers differently?