SQL: Modifications and Transactions

- Problem Set #1 is due before midnight tonight.

"We would like to be genetically modified to taste like Brussels sprouts."

AllPosters

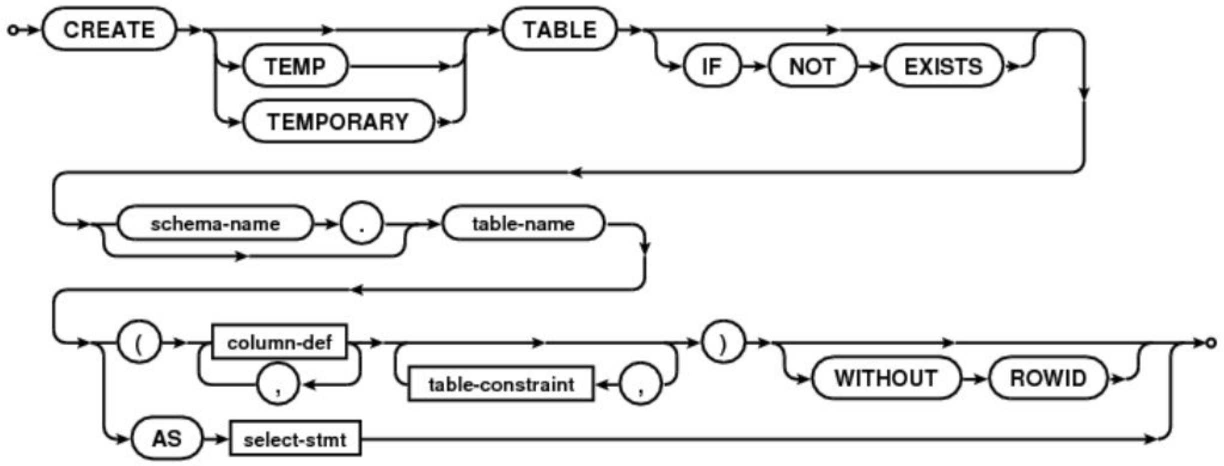
Creating Tables

- CREATE TABLE is the paramount SQL command
- The combination of all create table commands define the database's schema
- Most Integrity Constraints (ICs) are specified as part of CREATE TABLE

```
CREATE [TEMPORARY] TABLE [IF NOT EXISTS] TableName (
    Attr1 type [PRIMARY KEY [AUTOINCREMENT]] [DEFAULT value],
    Attr2 type [DEFAULT value],
    ...
    AttrN type [DEFAULT value],
    [PRIMARY KEY (AttrX,AttrY, …), -- composite key]
    [FOREIGN KEY(AttrX) REFERENCES Table(AttrY)
          [ON DELETE Action],]
    [UNIQUE (AttrX,AttrY, …),]
    [CHECK (expr),]
)
```

Offical SQL Syntax

- From sqlite.org/lang_createtable.html



These diagrams are often useful when composing and debugging queries

Example Create Table commands

- For our Yacht club:

```
CREATE TABLE IF NOT EXISTS Sailors (
    sid INTEGER  PRIMARY KEY AUTOINCREMENT,
    sname TEXT NOT NULL,
    rating INTEGER DEFAULT 1,
    age REAL NOT NULL,
    CHECK ((rating >= 1) AND (rating < 10))
)

CREATE TABLE Boats (
    bid INTEGER  PRIMARY KEY AUTOINCREMENT,
    bname TEXT NOT NULL,
    color TEXT DEFAULT ''
)

CREATE TABLE Reserves (
    sid INTEGER NOT NULL,
    bid INTEGER NOT NULL,
    day DATE,
    PRIMARY KEY (sid,bid,day),
    FOREIGN KEY(sid) REFERENCES Sailors(sid),
    FOREIGN KEY(bid) REFERENCES Boats(bid)
)
```

Creating tables from queries

- Relations can be derived from other tables

```
CREATE TEMPORARY TABLE BoatUses AS
    SELECT bid, COUNT(bid) AS uses
    FROM Reserves
    GROUP BY bid;
```

- And "SELECT * FROM BoatUses" gives:
  - Can serve as temporary relations used in complex transactions
  - Can lead to redundancy and inconsistency
  - Has no ICs

bid	uses
101	2
102	3
103	3
104	2

Altering Tables

- Schemas can be modified and ICs added to an existing table
- Add a new “made” column to track the day that a reservation is made on

```
ALTER TABLE Reserves ADD COLUMN
    made DATE CHECK (made <= day)
```

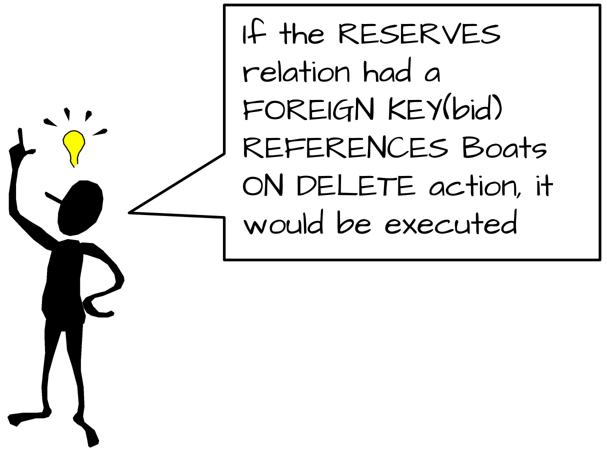
- Note: CHECK constraints are not teed against preexisting tuples in the table
- Rename an existing table

```
ALTER TABLE PlayedFor RENAME TO Roster
```

Dropping Tables

- DROP TABLE removes a relation from a database. It is completely removed– its definition and tuples, and it can not be recovered.
- If FOREIGN KEY constraints are defined, a DROP TABLE will generate DELETE FROM commands for each tuple.

```
DROP TABLE Boats
```


If the RESERVES relation had a FOREIGN KEY(bid) REFERENCES Boats ON DELETE action, it would be executed

Insert

❖ The INSERT command adds tuples to the database. ICs are checked.

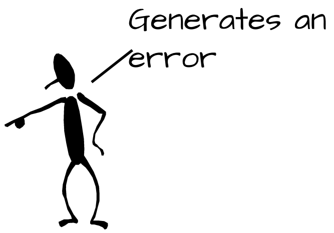
```
INSERT INTO Sailors(sid, sname, rating, age)
    VALUES(81, "Dusty", 5, 23.0)
```

❖ If all attributes are included in order the following simple form can be used

```
INSERT INTO Sailors
    VALUES(80, "Crusty", 6, 32.0)
```

❖ Fails if any IC is violated, i.e. repeating a primary key

```
INSERT INTO Sailors
    VALUES(81, "Dusty", 6, 24.0)
```



Replace

- Can use REPLACE to change an existing tuple (primary key must appear)

```
REPLACE INTO Sailors
    VALUES(81, "Dusty", 6, 24.0)
```

- "INSERT OR REPLACE" inserts a new tuple if the primary key does not already appear, and replaces a tuple if it does

```
INSERT OR REPLACE INTO Sailors
    VALUES(81, "Dusty", 6, 24.5)
```

Update

- If a only a subset of relation attributes are specified in an INSERT or REPLACE command the remainder are set according to their DEFAULT clause.
- If one desires to change selected attributes of a tuple, the UPDATE command is provided.

```
UPDATE Sailors
SET rating = rating + 1
WHERE rating < 10
```

```
UPDATE Sailors
SET age = 46.0, rating = 10
WHERE sid = 22
```

```
UPDATE Sailors
SET age = age + 1
WHERE sname like "_us%"
```

Delete

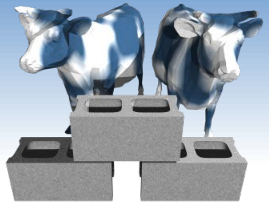
- DELETE removes entire tuples from a relation that satisfy an optional condition

```
DELETE FROM Sailors
WHERE age > 5 * rating
```

- DELETE without a condition removes all tuples but retains the table's definition (contrast with drop table)
- DELETE may cause side-effects depending on ICs

Database Transactions

- An important database concept
- Provides concurrency and durability
- A transaction consists of a *sequence of SQL commands* that might potentially change the contents of the database.
- These commands are considered as *atomic*
  - Final contents of the database are as if each command was executed in sequence with no intervening changes to the database's contents
  - All or none of the commands are executed
  - Database can be "Rolled back" to a state as if none of the transaction's commands were executed



Begin, Commit, and Rollback

- No changes are made to the database until a transaction is committed.
- Any command that changes the database implicitly starts a transaction if one is not already in effect.
- One can explicitly start a transaction with the BEGIN TRANSACTION command
- Commands within a transaction can access the intermedaite chages and results of previous commands, but they do not appear in the database until an explicit COMMIT TRANSACTION command
- If during a transaction a user decides to abort that series of changes made, a ROLLBACK TRANSACTION command be used.

Summary

- SQL provides commands for describing, querying, and modifying a database.
- A database's schema and integrity constraints are defined by CREATE TABLE commands
- Tuples are inserted into relations via the INSERT and REPLACE commands, and removed using DELETE
- Specific attributes of a relation's tuples are modified using UPDATE
- A transaction groups a set of commands into a single "atomic" operation.