Announcements

- Test 1 will cover material from:
  - lecture material from weeks 1 through 4
  - activities from weeks 1 through 4
  - demo sessions: 1, 2, 3, and 4
  - assignments: 1, 2, 3, and 4
- Demos 1 and 2 are graded and entered into d2l
- Demo 3 will soon be entered
- Grading scheme for demos – written & live questions:

  3 points – meets expectations; answer is correct
  2 points – needs improvement; answer is on the right track
  1 point – unsatisfactory; answer is not close to right
  0 points – question was not attempted
- Assignment 1 is graded and will be returned tonight

DATABASE MODIFICATIONS AND CONSTRAINTS IN SQL

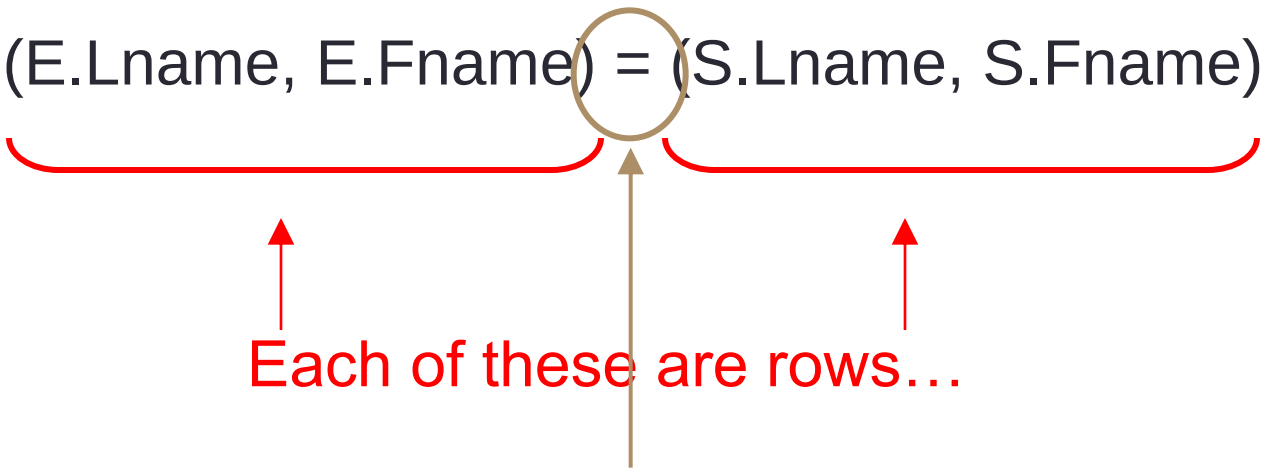
Lois Delcambre

Winter 2013

row value constructors in SQL:1999

- A row value constructor allows you to create a row “on the fly” for example:

```
WHERE (E.Lname, E.Fname) = (S.Lname, S.Fname)
```



and the equality comparison is doing a pair-wise comparison on the two rows.

table value constructors in SQL:1999

- You can also create a table “on the fly”

  VALUES row-value-expr, …, row-value-expr

  Example:

  ```
  INSERT INTO movie_stars
  VALUES (“Rocky Horror Picture Show”, 1977, “Curry, Tim”),
         (“Rocky V”, 1984, “Stallone, Sylvester”);
  ```

- The part circled in GREEN is a row-value expression.

- The part shown in RED font is a table value constructor

What about row/table constructors in relational algebra?

If you need to have either a row or a relation, you can just define it and then use it in relational algebra.

You could say something like:
Let R = {(“John”, 5, “male”), (“Sue”, 6, “female”)}

or let R be the table

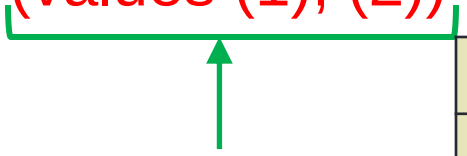
Name	Age	Gender
John	5	male
Sue	6	female

and then use R in expressions … like R X Student …or whatever

Row value constructors in SQL

- in the from clause:

```
select *
from sailors, (values (1), (2)) as x
```



This is a table-value constructor.
This creates a temporary table (with
has just one attribute. The table has
one with value 1 and the one with va

What answer would you expect from

sid	sname	rating	age	column1
64	Horatio	7	35	1
64	Horatio	7	35	2
74	Horatio	9	35.5	1
74	Horatio	9	35.5	2
22	Dustin	1	45	1
22	Dustin	1	45	2
31	Lubber	8	*NULL*	1
31	Lubber	8	*NULL*	2
	…			

Inserting rows into a table

insert into <relation-name> (a_1, a_2, a_3, … , a_n)

values (v_1, v_2, v_3, … , v_n);

If an attribute is not listed, the default value will be used.
You can list more than one row-value expression (like prior slide).

insert into <relation-name> values (v_1, v_2, v_3, … , v_n);

No attributes listed; values must be in the proper order (as defined).

```
insert into sailors(sid)
        Select DISTINCT sid from reserves
        Where sid not in
        (Select sid from sailors);
```

You can use a subquery to deliver rows to be inserted.

Deleting rows from a table

delete from <tablename> where <condition>;

The <condition> specifies what tuple(s) to be deleted.

To delete several tuples, use a condition satisfied by several tuples

delete from agent where salary > 8000;

Updating rows in a table

update <tablename> set <attribute> = value
where <condition>;

Here's an example:

```
update agent
set address = '111 E Portlandia Ave'
where agent_id = 99
```

Constraints in a DB

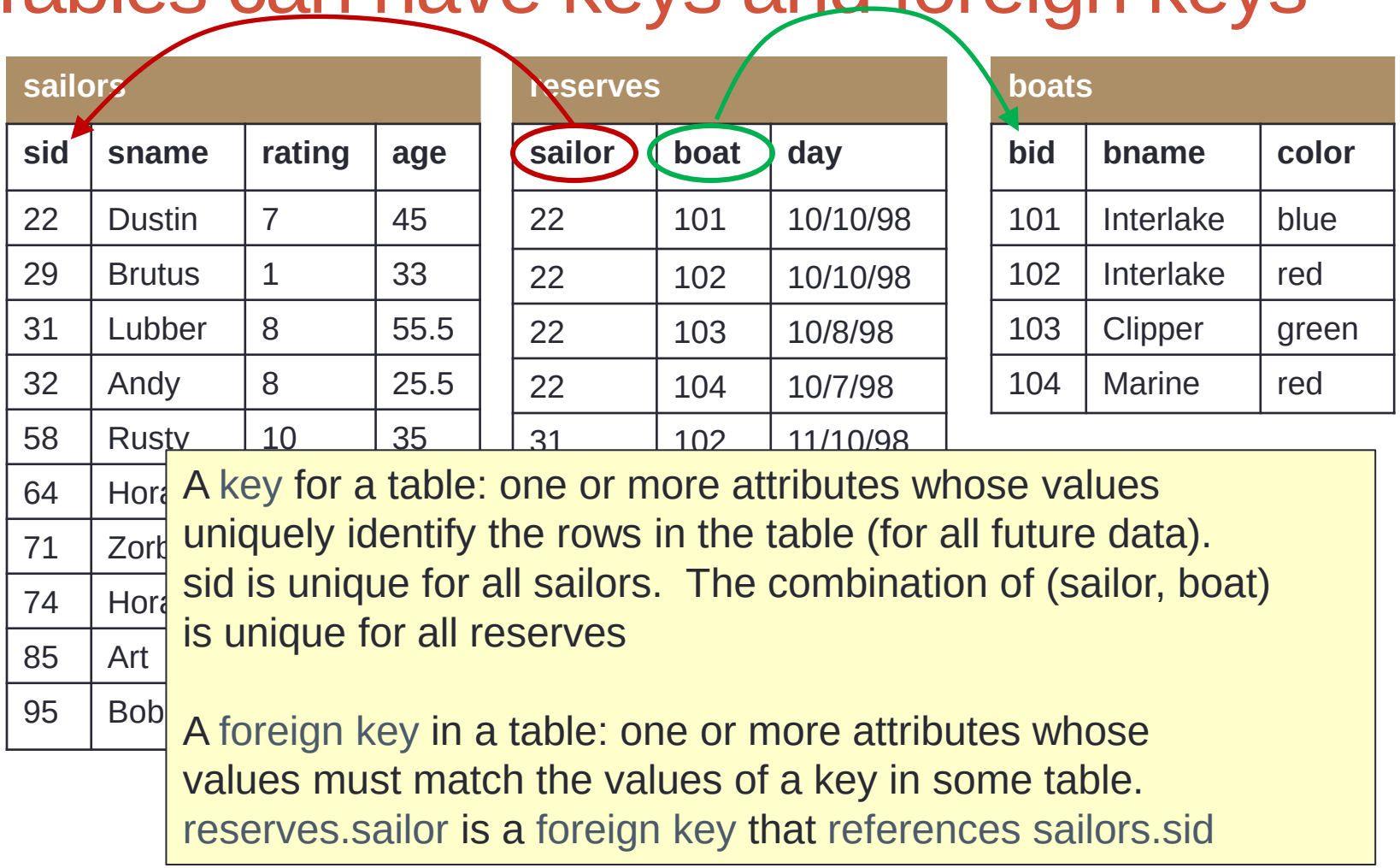
- If we don't have any constraints, then the table is kind of like a spreadsheet – we can put any data in any table. (We only have to use the right data type – to match the attribute definition in the create table statement.)

- So, what mechanisms to we have for constraints in SQL:
  - primary key and unique constraints for a table
  - check constraints on an attribute value that can appear (beyond just type constraints) including NOT NULL constraint
  - check constraints on a tuple
  - assertions (not yet implemented in postgresql)
  - triggers (that can include code) similar to DB procedures

Primary key and Unique Constraints

- We've already seen these; one or several attributes can be declared to be a primary key.
- One or several attributes can be declared to be unique.
- Look at the key for the languagerel in the Spy database to see a key that consists of two attributes:
  (lang_id, agent_id)
- If a table has two keys, then you can declare one to be a primary key and the other to be unique. You can also declare two different unique constraints.

Tables can have keys and foreign keys



sailors

sid	sname	rating	age
22	Dustin	7	45
29	Brutus	1	33
31	Lubber	8	55.5
32	Andy	8	25.5
58	Rusty	10	35
64	Hora		
71	Zorb		
74	Hora		
85	Art		
95	Bob		

reserves

sailor	boat	day
22	101	10/10/98
22	102	10/10/98
22	103	10/8/98
22	104	10/7/98
31	102	11/10/98

boats

bid	bname	color
101	Interlake	blue
102	Interlake	red
103	Clipper	green
104	Marine	red

A key for a table: one or more attributes whose values uniquely identify the rows in the table (for all future data). sid is unique for all sailors. The combination of (sailor, boat) is unique for all reserves

A foreign key in a table: one or more attributes whose values must match the values of a key in some table. reserves.sailor is a foreign key that references sailors.sid

Foreign key can't be violated (referential integrity)

- For a table that references another table (like bid in reserves), it must point to a valid row (e.g., to a bid that is in the boats table).

- The second row has an invalid bid (107) because there is not row in the boats table with 107.

  (Only part of the reserves table is shown here.)

boats

bid	bname	color
101	Interlake	blue
102	Interlake	red
103	Clipper	green
104	Marine	red

reserves

sid	bid	day
22	101	10/10/98
22	107	10/10/98
22	103	10/8/98
22	104	10/7/98
31	102	11/10/98
…		

Foreign keys in a schema

```
create table sailors (
    sid  integer  primary key,
    sname  character varying (30),
    rating    integer,
    age       integer)
create table reserves (
    sid  integer references sailors (sid),
    bid  integer,
    day date,
    primary key (sid, bid, day))
```

Foreign key constraints

```
create table reserves (
sid integer references sailors (sid),
bid integer,
day date);
```

```
create table reserves (
sid integer
bid integer,
day date)
foreign key (sid) references sailors (sid);
```

```
create table reserves (
sid integer
bid integer,
day date)
constraint fk1 foreign key (sid) references sailors (sid);
```

When does a foreign key need to be checked?

```
create table sailors (
sid  integer primary key,
sname character varying (30));

create table reserves (
sid integer references sailors (sid),
bid integer,
day date);
```

When you insert a sailor? When you insert a reservation?

When you delete a sailor? When you delete a reservation?
When you modify an sid in sailor? When you modify an sid in a reservation?

Naming constraints

```
create table sailors (
sid integer primary key,
sname);
create table sailors (
sid integer constraint pk1 primary key,
sname);
create table reserves (
sid integer constraint fk2 references sailors(sid),
bid integer,
day date);
```

Three policies for FK enforcement for deletes and updates

```
create table reserves(
sid integer references sailors(sid)
    on delete cascade
    on update cascade,
bid integer);
create table reserves(
sid integer references sailors(sid)
    on delete set null
    on update set null,
bid integer);
```

Note: the default policy is to reject the update if FK is violated.

Named constraints can be dropped or added to tables

alter table <tablename> drop constraint <constraintname>

alter table <tablename> add constraint <constraintname>
primary key (a1, a2, a3, ..)

alter table <tablename> add constraint <constraintname>
foreign key (a1, a2, …) references <tablename>(b1, b2, …)

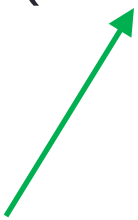
Constraints on attribute values

- not null
- primary key
- references
- check (condition)
  - check (salary > 20000)
  - check (gender in (‘f’, ‘m’)
  - check (agent_id in <subquery>)
    This is NOT allowed in postgresql; you can’t use a subquery.
- When are these constraints checked?

Constraints on tuples

At the end of a create table statement, you can put:

check (condition)



This condition is like any WHERE clause; you can mention any of the attributes in this table.

SQL allows a subquery in the condition but postgresql does not.
Read the book to see the risk; postgresql has made a reasonable choice.

Tuple-based check constraint

```
create table sailors(
sid integer constraint pksid primary key,
sname character varying (30) not null,
rating integer,
age integer
check (rating < age));
create table sailors(
sid integer constraint pksid primary key,
sname character varying (30) not null,
rating integer,
age integer
constraint ratingsmall check (rating < age));
```

Assertions in SQL

CREATE ASSERTION <assertionname>
CHECK (condition);

Condition can be any condition; can involve arbitrary subqueries. Can use EXISTS, NOT EXISTS, etc.

Write a condition for an assertion that will check for violation of a foreign key.

When is an assertion checked? How often would that constraint be checked? Compare that to how often (and for how much data) a foreign key constraint would be checked.

Triggers in SQL

Trigger = ECA rules = event/condition/action rules

You can trigger – before or after some triggering event.

A triggering event is: an insert, delete, or update for a table. (We'll talk about transactions later.)

When awakened, a trigger tests a condition. It it's true, then the trigger action is executed.

In postgresql, the action must be a user-defined function.

STORED FUNCTIONS & MODULES IN POSTGRES

by Neena Maldikar

PSM (Persistent Stored Modules)

- An example of a stored function in PostgreSQL:

```
CREATE OR REPLACE FUNCTION delete_movies(
       IN in_title CHAR(50),
       IN in_year  INTEGER
       )
RETURNS void AS $$
BEGIN
       DELETE FROM movies
       WHERE title = in_title
         AND year = in_year;
END;
$$ LANGUAGE plpgsql;
```

- To call the Stored Function, we can query as follows:

```
SELECT delete_movies('Hugo', 2011)
```

PSM (Persistent Stored Modules)

- An example of a function in Postgres that returns a value

```
CREATE OR REPLACE FUNCTION get_genre(title_in
char, year_in int) RETURNS varchar AS $$
DECLARE
     genre_ret varchar;
BEGIN
    SELECT genre INTO genre_ret
      FROM movies
     WHERE title = title_in
       AND year = year_in;
    RETURN genre_ret;
END;
$$ LANGUAGE plpgsql;
```

- To call the Stored Function, we can query as follows:

```
SELECT get_genre('Star Wars', 1977)
```

PSM (Persistent Stored Modules)

- An example of a function in Postgres that returns multiple results. (It must be declared to return SETOF some type.)

```
CREATE OR REPLACE FUNCTION get_movies()
RETURNS SETOF movies AS $$
DECLARE
        row RECORD;
BEGIN
        FOR row IN (Select * From movies )
            LOOP
              RETURN NEXT row;
            END LOOP;
        END;
$$ LANGUAGE plpgsql;
```

- To call the Stored Function, we can query as follows:

```
SELECT * FROM get_movies()
```

PSM (Persistent Stored Modules)

- An example of a function in Postgres that uses IF – THEN – END IF and inserts rows.

```
CREATE OR REPLACE FUNCTION update_movies( )
RETURNS integer AS $$
DECLARE
        row RECORD;
        counter INTEGER;
BEGIN
     counter = 0;
     FOR row IN SELECT * FROM movies
        LOOP
            IF (row.length > 100) THEN
                INSERT INTO movies1(title, year, genre)
                VALUES (row.title, row.year, row.genre);
                counter  = counter + 1;
            END IF;
        END LOOP;
     RETURN counter;
END;
$$ LANGUAGE plpgsql;
```

PSM (Persistent Stored Modules)

- An example of a funciton that returns cursors: (We have to use *refcursor* return type.)

```
CREATE OR REPLACE FUNCTION get_moviescur(
        ref refcursor
        )
RETURNS refcursor AS $$
BEGIN
      OPEN ref FOR SELECT * FROM movies;
      RETURN ref;
END;
$$ LANGUAGE plpgsql;
```

- To call the Stored Function, we can query as follows:

```
SELECT show_movies('movies_cur');
FETCH ALL IN "movies_cur";
```

Triggers

Classes (class , type , country, numGuns, bore, displacem ent)

Ships(name, class, launched)

When a new class is inserted into Classes, also insert a ship with the name of that class and a NULL launch date.

```
CREATE TRIGGER AddShipTrigger
AFTER INSERT ON Classes
REFERENCING
        NEW ROW AS NewRow
FOR EACH ROW
INSERT INTO Ships(name, class , launched)
        VALUES (NewRow.class, NewRow.class, NULL);
```

Triggers – Implementation in Postgres

```
CREATE FUNCTION shipTrigger()
RETURNS trigger AS $$
    BEGIN
      INSERT INTO Ships(name, class , launched)
      VALUES (New.class, New.class, NULL);
      RETURN NULL;
    END;
$$ LANGUAGE plpgsql;

CREATE TRIGGER AddShipTrigger
AFTER INSERT ON Classes
FOR EACH ROW EXECUTE PROCEDURE shipTrigger();
```

SQLs for creating tables.

```
CREATE TABLE Classes (
  class VARCHAR(50) PRIMARY KEY,
  type CHAR (2),
  country VARCHAR(50),
  numGuns INT,
  bore INT,
  displacement INT)
CREATE TABLE Ships (
  name VARCHAR(50) PRIMARY KEY,
  class VARCHAR(50),
  launched INT,
  FOREIGN KEY (class) REFERENCES Classes (class)
);
INSERT INTO classes(class , type , country, numGuns, bore,
  displacement)VALUES('Iowa','bb','usa', 9, 16, 46000);
```

References:

- http://www.eioba.com/a/1ign/a-basic-introduction-to-postgres-stored-procedures
- http://wischner.blogspot.com/2009/03/creating-stored-procedure-function.html
- http://www.postgresql.org/docs/8.0/static/plpgsql.html