CS 580 Client-Server Programming
Spring Semester, 2005
Doc 18 SQL, Joins & Normalization
Contents

References

Oracle Design, Ensor & Stevenson, O'Reilly & Associates, Inc., 1997

MySQL On-line Manual http://www.mysql.com/doc/en/Reference.html

PostgreSQL Commands http://www.postgresql.org/idocs/index.php?sql-commands.html

Some Data Modeling Terms

Entity

A distinct class of things about which something is known

Entity Occurrence

Particular instance of an entity class

In a database entity occurrences are records in a table

Attribute

An abstraction belonging to or characteristic of an entity

Primary Key (unique identifier)

An attribute (or set of attributes) that uniquely define an entity

Relationship

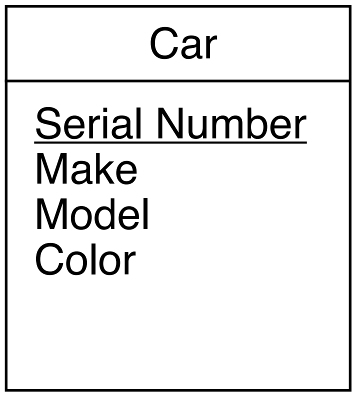
An abstraction belonging to or characteristic of two entities or parts together

Relational databases do not support pointers to entities

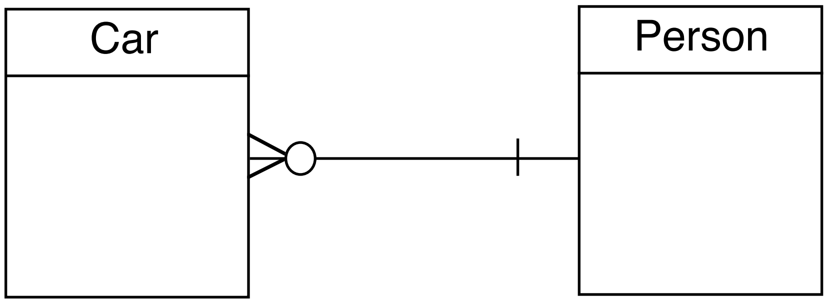
Foreign Key

A unique identifier in a record representing another record

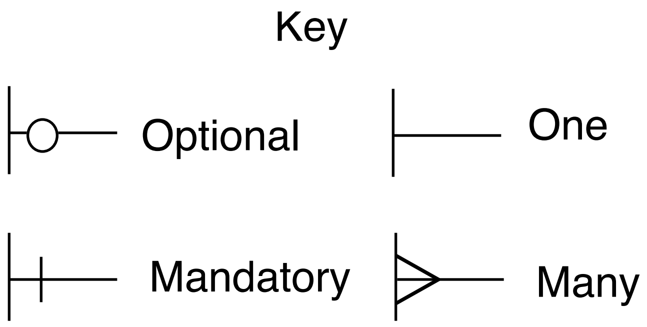
Entity Relationship Diagram (ERD)



Entity (car) with:
- Attributes (Color, make, model, serial number)
- Primary key (serial number)



Relationship between Car and Person entities
- Car must have one and only one owner
- Person may own zero, one or more cars
- Person can own many cars



An Example
Primary Key

A primary key is one that uniquely identifies a row in a table

A Silly Table

name	faculty_id
Whitney	1
Beck	2
Anantha	3

PostgreSQL Version

```
CREATE TABLE faculty (
   name  CHAR(20) NOT NULL,
   faculty_id  SERIAL   PRIMARY KEY
);
```

MySQL Version

```
CREATE TABLE faculty (
   name  CHAR(20) NOT NULL,
   faculty_id  INTEGER AUTO_INCREMENT   PRIMARY KEY
);
```

Indices

Indices make accessing faster

Primary keys automatically have an index

The CREATE INDEX command creates indices

```
    CREATE INDEX faculty_name_key on faculty (name);
```

Adding Values

```
INSERT INTO  faculty ( name) VALUES    ('Whitney');
INSERT INTO  faculty ( name) VALUES    ('Beck');
INSERT INTO  faculty ( name) VALUES    ('Anantha');
INSERT INTO faculty ( name) VALUES ('Vinge');

select * from faculty;
```

Result

```
        name        | faculty_id
--------------------+------------
 Whitney            |          1
 Beck               |          2
 Anantha            |          3
 Vinge              |          4
(4 rows)
```

Note PostgreSQL allows one to drop the list of column names:

```
INSERT INTO faculty  VALUES ('Vinge');
```

A Second Table

PostgreSQL

```
CREATE TABLE office_hours (
    start_time    TIME NOT NULL,
    end_time    TIME NOT NULL,
    day    CHAR(3) NOT  NULL,
    faculty_id INTEGER REFERENCES faculty,
    office_hour_id    SERIAL    PRIMARY KEY
);
```

MySQL

```
CREATE TABLE office_hours (
    start_time    TIME NOT NULL,
    end_time    TIME NOT NULL,
    day    CHAR(3) NOT  NULL,
    faculty_id INTEGER REFERENCES faculty,
    office_hour_id INTEGER AUTO_INCREMENT PRIMARY KEY
);
```

faculty_id is a foreign key

REFERENCES faculty insures that only valid references are made

start_time	end_time	day	faculty_id	office_hour_id
10:00	11:00	Wed	1	1
8:00	12:00	Mon	2	2
17:00	18:30	Tue	1	3
9:00	10:30	Tue	3	4
9:00	10:30	Thu	3	5
15:00	16:00	Fri	1	6

Office_Hours adding Simple Insert

```
INSERT
    INTO office_hours ( start_time, end_time, day, faculty_id )
    VALUES ( '10:00:00',  '11:00:00' ,  'Wed',  1 );
```

The problem is that we need to know the id for the faculty

Using Select

```
INSERT INTO
   office_hours  (start_time, end_time, day, faculty_id )
SELECT
   '8:00:00' AS start_time,
   '12:00:00' AS end_time,
   'Mon' AS day,
   faculty_id AS faculty_id
FROM
   faculty
WHERE
   name = 'Beck';
```

Getting Office Hours

```
SELECT
    name, start_time, end_time, day
FROM
    office_hours, faculty
WHERE
    faculty.faculty_id = office_hours.faculty_id;
```

name	start_time	end_time	day
Whitney	10:00:00	11:00:00	Wed
Beck	08:00:00	12:00:00	Mon
Whitney	17:00:00	18:30:00	Tue
Whitney	15:00:00	16:00:00	Fri
Anantha	09:00:00	10:30:00	Tue
Anantha	09:00:00	10:30:00	Thu

Some Formatting

PostgreSQL only

```
SELECT
    name AS Instructor,
    TEXT(start_time) || ' to ' || TEXT(end_time) AS Time,
    day AS Day
FROM
    office_hours, faculty
WHERE
    faculty.faculty_id = office_hours.faculty_id
ORDER BY
    Name;
```

Instructor	Time	Day
Anantha	09:00:00 to 10:30:00	Tue
Anantha	09:00:00 to 10:30:00	Thu
Beck	08:00:00 to 12:00:00	Mon
Whitney	10:00:00 to 11:00:00	Wed
Whitney	17:00:00 to 18:30:00	Tue
Whitney	15:00:00 to 16:00:00	Fri

Some Selection

```
SELECT
   name, start_time, end_time, day
FROM
   office_hours, faculty
WHERE
   faculty.faculty_id = office_hours.faculty_id
 AND
   start_time > '09:00:00'
 AND
   end_time < '16:30:00'
ORDER BY
   Name;
```

name	start_time	end_time	day
Whitney	10:00:00	11:00:00	Wed
Whitney	15:00:00	16:00:00	Fri

Joins

People

id	first_name	last_name
1	Roger	Whitney
2	Leland	Beck
3	Carl	Eckberg

Email_Addresses

id	user_name	host	person_id
1	beck	cs.sdsu.edu	2
2	whitney	cs.sdsu.edu	1
3	whitney	rohan.sdsu.edu	1
4	foo	rohan.sdsu.edu	

The tables have a column in common as email_addresses.person_id refers to people.id. So we can create a new table by joining the two tables together on that column

Inner Join (or just Join)

Only uses entries linked in two tables

first_name	last_name	user_name	host
Leland	Beck	beck	cs.sdsu.edu
Roger	Whitney	whitney	cs.sdsu.edu
Roger	Whitney	whitney	rohan.sdsu.edu

```
select
   first_name, last_name, user_name, host
from
   people, email_addresses
where
   people.id = email_addresses.person_id;
```

or equivalently

```
select
   first_name, last_name, user_name, host
from
   people inner join email_addresses
on
   (people.id = email_addresses.person_id);
```

Outer Join

Uses all entries from a table

Left Outer Join

Use all entries from the left table

first_name	last_name	user_name	host
Leland	Beck	beck	cs.sdsu.edu
Roger	Whitney	whitney	cs.sdsu.edu
Roger	Whitney	whitney	rohan.sdsu.edu
Carl	Eckberg		

```
select
   first_name, last_name, user_name, host
from
   people left outer join email_addresses
on
   (people.id = email_addresses.person_id);
```

Right Outer Join

first_name	last_name	user_name	host
Leland	Beck	beck	cs.sdsu.edu
Roger	Whitney	whitney	cs.sdsu.edu
Roger	Whitney	whitney	rohan.sdsu.edu
		foo	rohan.sdsu.edu

Use all entries from the right table

```
    select
       first_name, last_name, user_name, host
    from
       people right outer join email_addresses
    on
       (people.id = email_addresses.person_id);
```

A right outer join B & B left outer join A

The following two statements are equivalent

```
select
   first_name, last_name, user_name, host
from
   people right outer join email_addresses
on
   (people.id = email_addresses.person_id);
```

```
select
   first_name, last_name, user_name, host
from
   email_addresses left outer join people
on
   (people.id = email_addresses.person_id);
```

Normalization

Defined by Dr. E. F. Codd in 1970

Normal forms
 Reduce redundant data and inconsistencies

First Normal Form (1NF)

An entity is in the first normal form when all its attributes are single valued

Example - Office Hours

Name	OfficeHour1	OfficeHour2	OfficeHour3
Whitney	10:00-11:00 W	17:00-18:30 Tu	15:00-16:00 Fri
Beck	8:00-12:00 M		
Anantha	9:00-10:30 Tu	9:00-10:30 Thu	

What if someone has more than 3 office hours?
Wasted space for those that have fewer office hours

Not is 1NF since office hours are repeated

In 1NF Form

Faculty

name	faculty_id
Whitney	1
Beck	2
Anantha	3

Office Hours

start_time	end_time	day	faculty_id	office_hour_id
10:00	11:00	Wed	1	1
8:00	12:00	Mon	2	2
17:00	18:30	Tue	1	3
9:00	10:30	Tue	3	4
9:00	10:30	Thu	3	5
15:00	16:00	Fri	1	6

Second Normal Form (2NF)

An entity is in the second normal form if:

- It is in 1NF and
- All non-key attributes must be fully dependent on the entire primary key

Example 1- CDs

Put your collection of CD in a database

cd_title	artist	music_type	cd_id
Songs from the Trilogy	Glass	Modern Classical	1
I Stoten	Falu Spelmanslag	Swedish	2
Photographer	Glass	Modern Classical	3
etc.			

Table is not in 2NF since different CDs

- Can have the same artists
- Can have same music type

Example 2- Course Schedule

Name	Time	Days	Term	Schedule Number
CS635	1700-1815	MW	Spring01	09461
CS651	1700-1815	MW	Spring01	09472
CS672	1700-1815	MW	Spring01	09483
CS683	1830-1945	MW	Spring01	09494
CS696	1530-1645	MW	Spring01	09505
CS696	1830-1945	MW	Spring01	09516
CS696	1530-1645	TTh	Spring01	09520

At SDSU the schedule number uniquely identifies a course in a semester

So the term and schedule number uniquely identifies a course at SDSU

We can use term and schedule as the primary key

The table is in 1NF but not 2NF

Name, Time and Days are not fully dependent on the primary key

Schedule

course_id	time_id	term_id	schedule_number
1	1	2	09461
2	1	2	09472
3	1	2	09483
4	2	2	09494

Courses

course	title	name_id
CS635	Adv Obj Orient Dsgn Prog	1
CS651	Adv Multimedia Systems	2
CS672	Micro Computer Software	3
CS683	Emerging Technologies	4
CS696	Intell Systems & Control	5
CS696	Writing Device Drivers	6
CS696	Sem: Computer Security	7

Time

start_time	end_time	days	time_id
17:00:00	18:15:00	MW	1
18:30:00	19:45:00	MW	2
15:30:00	16:45:00	MW	3
15:30:00	16:45:00	TTh	4
Etc.			

Term

semester	year	term_id
Fall	2000	1
Spring	2001	2

Comments about Previous Slide

The schedule table is now in 2NF

What about the other tables?

If not how would you fix them?

Can you find a better way to decompose the original table?

Third Normal Form (3NF)

An entity is in third normal form if

- It is in 2NF and
- All non-key attributes must only be dependent on the primary key

Customer

Name	Address	City	State Name	State abbreviation	zip	id

State abbreviation depends on State Name

Table is not in 3NF

Other Normal Forms

- Boyce-Codd normal form (BCNF)
- Fourth normal form (4NF)
- Fifth normal form (5NF)

These are beyond the scope of this course

See your local database course/textbook