

CCT396, Fall 2011

Database Design and Implementation

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1:1 Relationships

Option 1:

Use the same table.

Option 2:

Use a single-attribute FK
as the PK in one of the tables.

Multivalued Attributes

customer:

name

phone number(s)

email address(es)

restaurant:

name

address

tag(s)

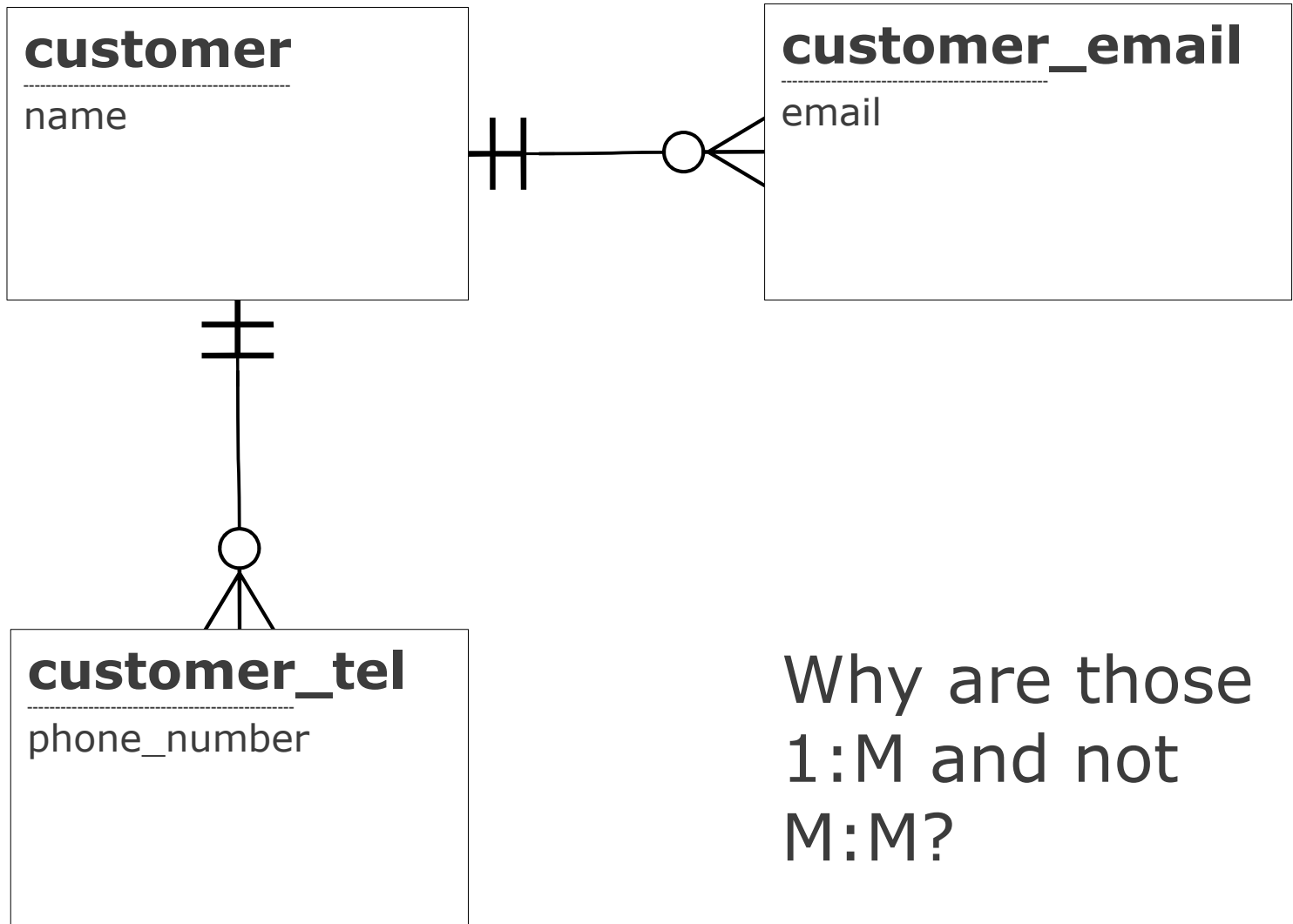
Multivalued Attributes

Problem:

Multivalued attributes may be ok in ER, but definitely not in a relational database.

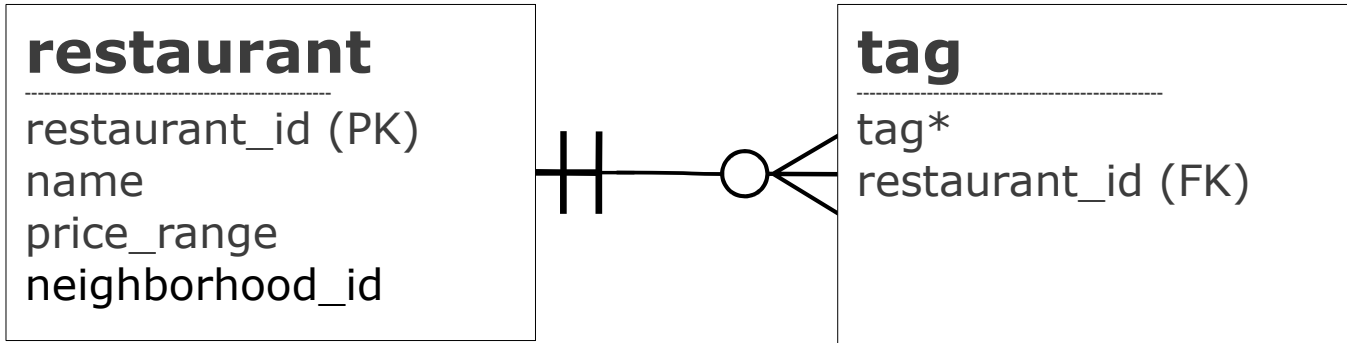
Solution:

Treat multivalued attributes as simple entities.

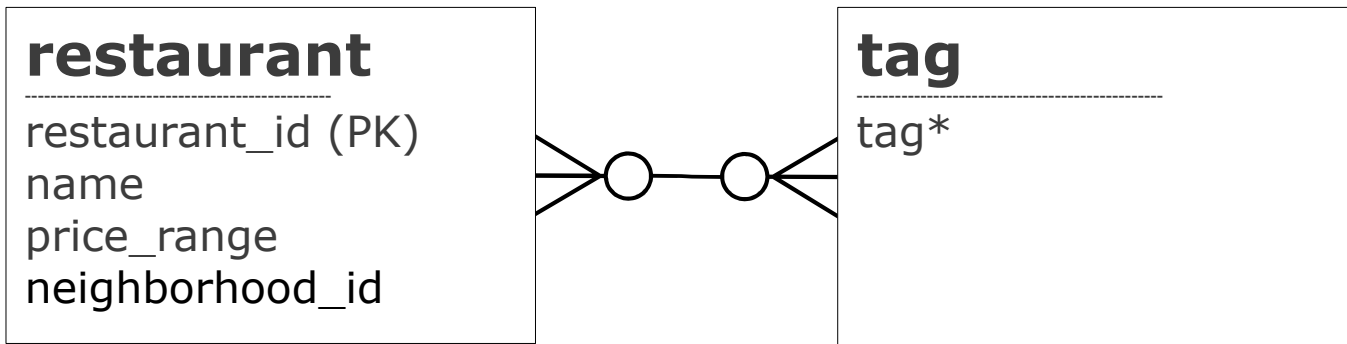


Why are those
1:M and not
M:M?

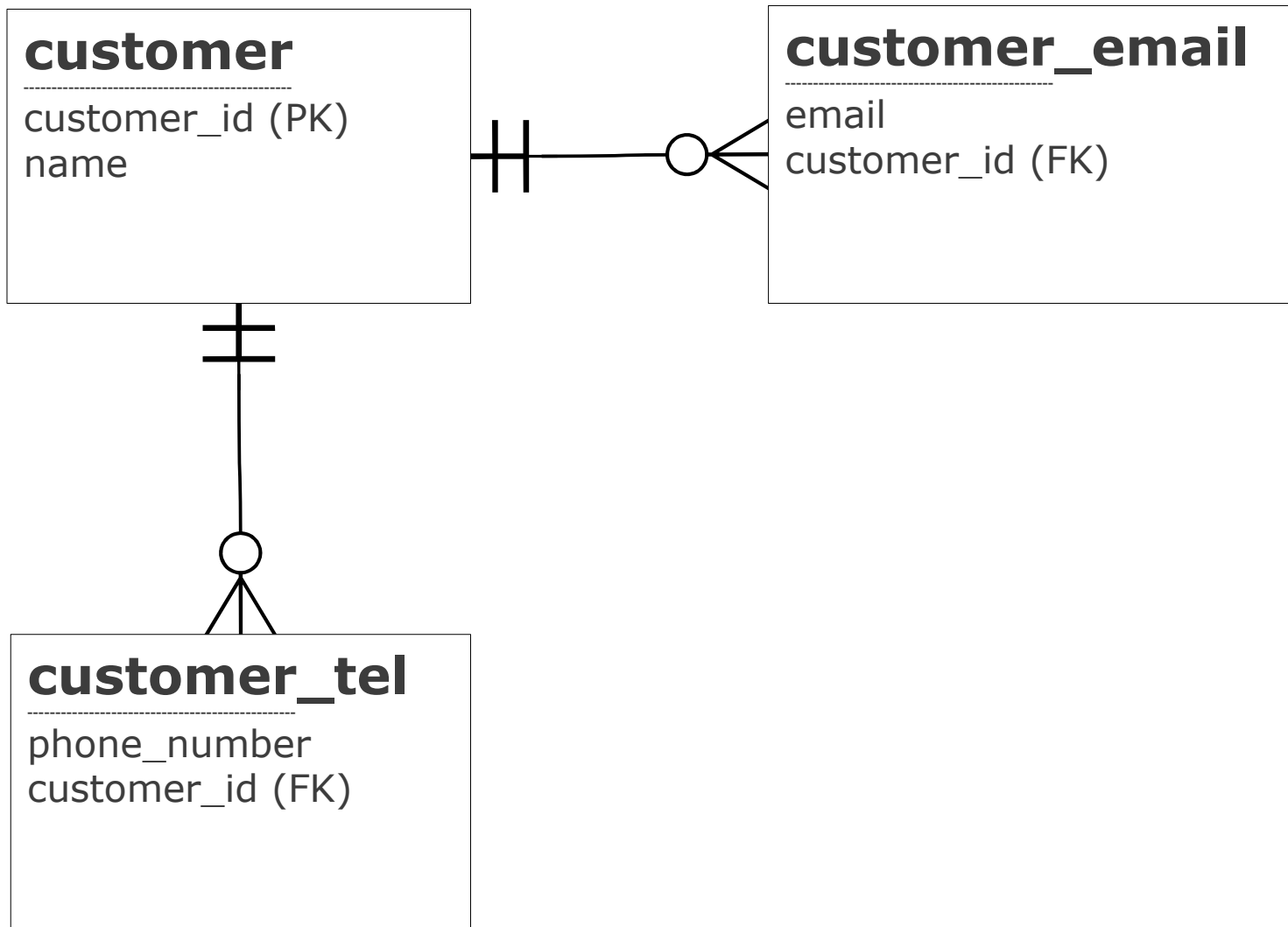
```
create table customer_email (  
    email varchar(100),  
    customer_id integer not null,  
    position integer,  
    primary key  
        (customer_id, email),  
    foreign key (customer_id)  
        references customer(list_id)  
);
```



or



?




```
create table customer_email (  
    email varchar(100),  
    customer_id integer not null,  
    primary key  
        (customer_id, email),  
    foreign key (customer_id)  
        references customer(list_id)  
);
```

Are we missing anything?

```
create table customer_email (  
    email varchar(100),  
    customer_id integer not null,  
    position integer,  
    primary key  
        (customer_id, email),  
    foreign key (customer_id)  
        references customer(list_id)  
);
```

CASE Tools

Allows designing in ER-like form and getting SQL generated automatically.

(Don't use this in this class.)

Week 5

Queries Using Multiple Tables

Linking the Tables

species

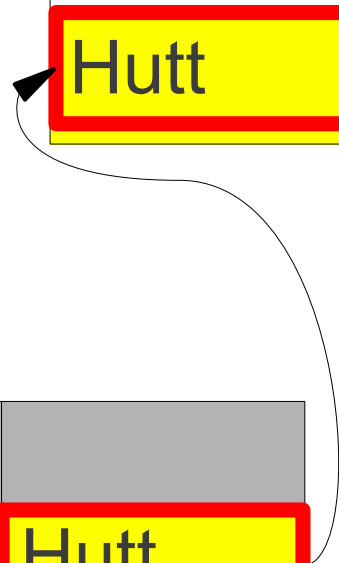
Human	humanoid	1.7
Hutt	gastropod	3.5

persona

Jabba	Hutt
Obiwan Kenobi	Human

species_type

gastropod	0
humanoid	2



Projection



name	owner	species	sex	birth
Fluffy	Harold	cat	f	1993-02-04
Bluffy	Harold	dog	f	1989-05-13
Chirpy	Gwen	bird	f	1998-09-11

Projection

name	species	sex
Fluffy	cat	f
Bluffy	dog	f
Chirpy	bird	f

Selection

("Restriction" in Harrington)



name	owner	species	sex	birth
Fluffy	Harold	cat	f	1993-02-04
Bluffy	Harold	dog	f	1989-05-13
Chirpy	Gwen	bird	f	1998-09-11

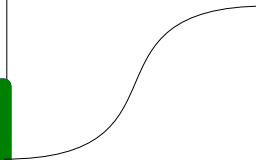
Multiple Tables

pet

name	owner	species
Fluffy	Harold	cat
Bluffy	Harold	dog
Chirpy	Gwen	bird

species

name	food
dog	dog food
bird	seeds
cat	cat food



Join

name	owner	species	food
Fluffy	Harold	cat	cat food
Bluffy	Harold	dog	dog food
Chirpy	Gwen	bird	seeds

Cartesian Product

$$\left\{ \begin{array}{l} \text{Fluffy} \\ \text{Buffy} \\ \text{Chirpy} \end{array} \right\} \times \left\{ \begin{array}{l} \text{dog} \\ \text{cat} \\ \text{bird} \end{array} \right\} = \left\{ \begin{array}{l} (\text{Fluffy}, \text{dog}) \\ (\text{Fluffy}, \text{cat}) \\ (\text{Fluffy}, \text{bird}) \\ (\text{Buffy}, \text{dog}) \\ (\text{Buffy}, \text{cat}) \\ (\text{Buffy}, \text{bird}) \\ (\text{Chirpy}, \text{dog}) \\ (\text{Chirpy}, \text{cat}) \\ (\text{Chirpy}, \text{bird}) \end{array} \right\}$$

Product of Tables

pet

name	owner	species
Fluffy	Harold	cat
Bluffy	Harold	dog
Chirpy	Gwen	bird

×

species

name	food
dog	dog food
bird	seeds
cat	cat food

name	owner	species	species	food
Fluffy	Harold	cat	cat	cat food
Bluffy	Harold	dog	cat	cat food
Chirpy	Gwen	bird	cat	cat food
Fluffy	Harold	cat	dog	dog food
Bluffy	Harold	dog	dog	dog food
Chirpy	Gwen	bird	dog	dog food
Fluffy	Harold	cat	bird	seeds
Bluffy	Harold	dog	bird	seeds
Chirpy	Gwen	bird	bird	seeds

name	owner	species	species	food
Fluffy	Harold	cat	cat	cat food
Bluffy	Harold	dog	cat	cat food
Chirpy	Gwen	bird	cat	cat food
Fluffy	Harold	cat	dog	dog food
Bluffy	Harold	dog	dog	dog food
Chirpy	Gwen	bird	dog	dog food
Fluffy	Harold	cat	bird	seeds
Bluffy	Harold	dog	bird	seeds
Chirpy	Gwen	bird	bird	seeds

name	owner	species	species	food
Fluffy	Harold	cat	cat	cat food
Bluffy	Harold	dog	cat	cat food
Chirpy	Gwen	bird	cat	cat food
Fluffy	Harold	cat	dog	dog food
Bluffy	Harold	dog	dog	dog food
Chirpy	Gwen	bird	dog	dog food
Fluffy	Harold	cat	bird	seeds
Bluffy	Harold	dog	bird	seeds
Chirpy	Gwen	bird	bird	seeds

cartesian product + selection
=
relational join

selection based on equality

↓
"equi-join"

SQL-92 Inner Join

(aka "ANSI Join")

```
select ... from «table1»  
join «table2» on «conditions»;
```

```
select pet.name, species.food  
from pet join species  
on pet.species = species.name;
```

SQL-92 Inner Join

```
select ... from «table1»  
join «table2» on «conditions»;
```

```
select pet.name, species.food  
from pet join species  
on pet.species = species.name;
```

```

+-----+-----+
| name   | food   |
+-----+-----+
| Fluffy | cat food |
| Claws  | cat food |
| Buffy  | dog food |
| Fang   | dog food |
| Bowser | dog food |
| Chirpy | seeds   |
| Whistler | seeds  |
| Slim   | mice   |
+-----+-----+
8 rows in set (0.00 sec)

```

without the "on" clause →
 (depends on the db)

```

+-----+-----+
| name   | food   |
+-----+-----+
| Fluffy | cat food |
| Fluffy | dog food |
| Fluffy | seeds   |
| Fluffy | mice   |
| Claws  | cat food |
| Claws  | dog food |
| Claws  | seeds   |
| Claws  | mice   |
| Buffy  | cat food |
      ...
| Slim   | cat food |
| Slim   | dog food |
| Slim   | seeds   |
| Slim   | mice   |
| Puffball | cat food |
| Puffball | dog food |
| Puffball | seeds   |
| Puffball | mice   |
+-----+-----+
36 rows in set (0.00 sec)

```

pet

name *

owner

species

sex

birth

death

weight

birth_weight

species

name

food *

vaccination

```
select pet.name, species.food
from pet join species on
pet.species=species.name;
```

pet

name *

owner

species

sex

birth

death

weight

birth_weight

owner

name

telephone *

cc_no

cc_type

```
select pet.name, owner.telephone
from pet join owner on
pet.owner=owner.name;
```

pet

name *

owner

species

sex

birth

death

weight

birth_weight

event

name

date

type *

remark

```
select pet.name, event.type
from pet join event on
pet.name=event.name;
```

Table Aliases

```
select pet.name, species.food  
from pet join species  
on pet.species = species.name;
```



```
select p.name, s.food  
from pet as p join species as s  
on p.species = s.name;
```

Self-Join

```
select ...  
from «table» as «alias1»  
join «table» as «alias1»  
on «conditions»;
```

```
select p1.name, p2.name  
from pet as p1 join pet as p2  
on p1.species = p2.species  
where p1.name < p2.name;
```



```
+-----+-----+
| name   | name   |
+-----+-----+
| Claws  | Fluffy |
| Bowser | Buffy  |
| Buffy  | Fang   |
| Bowser | Fang   |
| Chirpy | Whistler |
+-----+-----+
5 rows in set (0.00 sec)
```

owner

name *
telephone
cc_no
cc_type

pet

name
owner
species
sex
birth
death
weight
birth_weight

species

name
food *
vaccination

```
owner join pet on...  
join species on...
```

Multiple Joins

```
select ... from «table1»  
join «table2» on «condition1»  
join «table3» on «condition2»;
```

```
select owner.name, food from owner  
join pet  
  on pet.owner = owner.name  
join species  
  on pet.species = species.name;
```

```
+-----+-----+
| name   | food   |
+-----+-----+
| Harold | cat food |
| Gwen   | cat food |
| Harold | dog food |
| Diane  | dog food |
| Gwen   | seeds   |
| Gwen   | seeds   |
+-----+-----+
6 rows in set (0.00 sec)
```

Easier Equi-Joins

pet

name	owner
Fluffy	Harold
Bluffy	Harold
Chirpy	Gwen
Fang	Benny

owner

name	telephone
Gwen	16472939823
Harold	14092938489
Diane	552122347849



Easier Equi-Joins

pet

pet_name	owner_name
Fluffy	Harold
Bluffy	Harold
Chirpy	Gwen
Fang	Benny

owner

owner_name	telephone
Gwen	16472939823
Harold	14092938489
Diane	552122347849



Join... Using...

```
select ... from «table1»  
join «table2»  
using («columns»);
```

```
select pet_name, food  
from pet join owner  
using (owner_name);
```

Yet Easier Equi-Joins

pet

pet_name	owner_name
Fluffy	Harold
Bluffy	Harold
Chirpy	Gwen
Fang	Benny

owner

owner_name	telephone
Gwen	16472939823
Harold	14092938489
Diane	552122347849



Natural Join

```
select ... from «table1»  
natural join «table2»;
```

avoid

```
select pet_name, food  
from pet natural join owner;
```

Why Avoid It?

implicit selection of columns
=
bad idea

“Traditional” Join

```
select ...  
from «table1», «table2»  
where «join_conditions»;
```

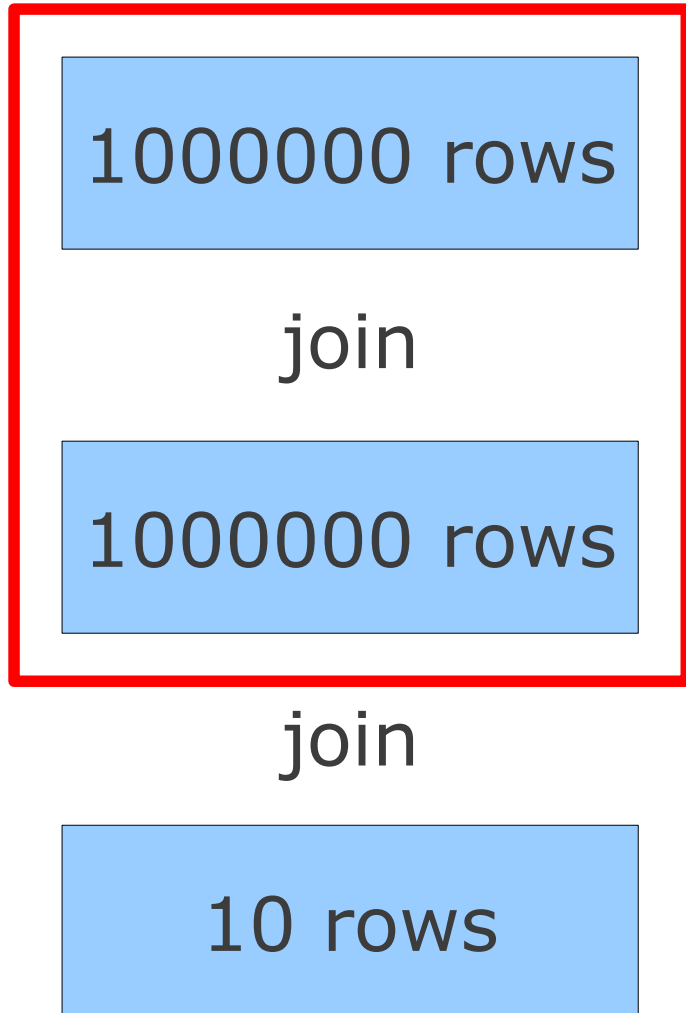
avoid

```
select name, food  
from pet, owner  
where pet.owner=owner.name;
```

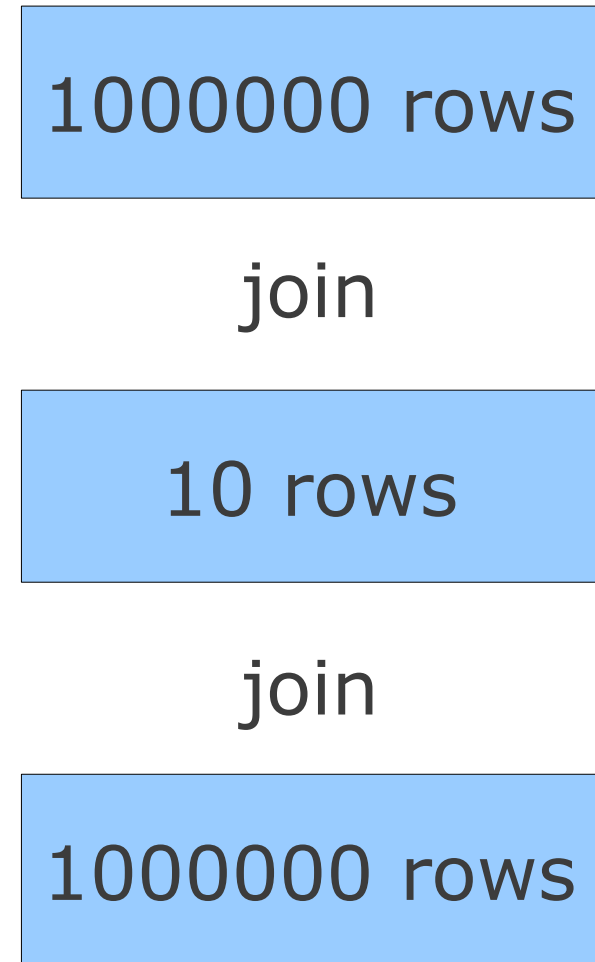
Use SQL-92 “Join”

- More options
 - e.g., “outer”
- More clear
 - avoids making “where” ambiguous
- Control over the order of joins

Order of Joins



vs



Questions?

Inner vs. Outer

Inner Join:

only pairs that satisfy the condition

Outer Joins:

includes non-matched rows from one of the tables, or both
-> "left", "right", "full"

Why Do Outer Joins?

pet

name	owner
Fluffy	Harold
Buffy	Harold
Chirpy	Gwen
Fang	Benny

owner

name	telephone
Gwen	16472939823
Harold	14092938489
Diane	552122347849

An Inner Join

pet join owner on pet.owner=owner.name

name	owner	telephone
Fluffy	Harold	14092938489
Buffy	Harold	14092938489
Chirpy	Gwen	552122347849

What happened to Fang?

What We Might Want


name	owner	telephone
Fluffy	Harold	14092938489
Bluffy	Harold	14092938489
Chirpy	Gwen	552122347849
Fang	Benny	NULL

Left Outer Join

```
select ... from «table1»  
left outer join «table2»  
on «conditions»;
```

include unmatched rows
from the **left** table

```
select pet.name, pet.owner,  
owner.telephone  
from pet  
left table left outer join owner  
on pet.owner = owner.name;
```



name	owner	telephone
Fluffy	Harold	14092938489
Claws	Gwen	16472939823
Buffy	Harold	14092938489
Fang	Benny	NULL
Bowser	Diane	552122347849
Chirpy	Gwen	16472939823
Whistler	Gwen	16472939823
Slim	Benny	NULL
Puffball	Diane	552122347849

9 rows in set (0.00 sec)

Other Outer Joins

Right Outer Join:

unmatched rows from the *right* table

Full Outer Join:

unmatched rows from *both* sides
(not available in mysql)

Back to StarWars

1. Which characters belong to species with typical lifespan > 200 years?
2. Which characters belong to species that come from worlds that are more than 50% water (by surface area)?

select

persona.name

from

persona

join world

where

world.percent_water > 50;

select

persona.name

from

persona

join ???

join world

where

world.percent_water > 50;


```
select
  persona.name
from
  persona
join species
  using (species)
join world
  on species.homeworld=
  world.world_name
where
  world.percent_water > 50;
```

Advanced Joins

3. Which characters come from worlds that have more water than the world where their species originated?

Hint: join **world** twice, with different aliases

The Two Worlds

```
select
    w1.world_name, w2.world_name
from world as w1
join world as w2
where
    w1.percent_water >
    w2.percent_water;
```

Persona + Species

```
select
  persona.name, species.species
from persona
join species on
  persona.species=species.species;
```

... + w1

```
select
  persona.name, species.species,
  w1.percent_water
from persona
join species on
  persona.species=species.species
join world as w1 on
  persona.homeworld=w1.world_name;
```

... + w2

```
select
  persona.name, species.species,
  w1.percent_water, w2.percent_water
from persona
join species on
  persona.species=species.species
join world as w1 on
  persona.homeworld=w1.world_name
join world as w2 on
  species.homeworld=w2.world_name;
```

Adding WHERE

```
select
  persona.name, species.species,
  w1.percent_water, w2.percent_water
from persona
join species on
  persona.species=species.species
join world as w1 on
  persona.homeworld=w1.world_name
join world as w2 on
  species.homeworld=w2.world_name
where
  w1.percent_water>w2.percent_water;
```

The Final Answer

```
select
  persona.name
from persona
join species on
  persona.species=species.species
join world as w1 on
  persona.homeworld=w1.world_name
join world as w2 on
  species.homeworld=w2.world_name
where
  w1.percent_water>w2.percent_water;
```


foreign key

(primary) key

pet_name	owner_name
Fluffy	Harold
Buffy	Harold
Chirpy	Gwen
Fang	Benny

owner_name	telephone
Gwen	16472939823
Harold	14092938489
Diane	552122347849

“Harold” is now “Bob”

pet_name	owner_name
Fluffy	Harold
Buffy	Harold
Chirpy	Gwen
Fang	Benny

owner_name	telephone
Gwen	16472939823
Bob	14092938489
Diane	552122347849

The Solution

pet_name	owner_id
Fluffy	2
Buffy	2
Chirpy	1
Fang	???



owner_id	owner_name	telephone
1	Gwen	16472939
2	Harold	14092939
3	Diane	55212234

The Solution

pet_name	owner_id
Fluffy	2
Buffy	2
Chirpy	1
Fang	4



owner_id	owner_name	telephone
1	Gwen	16472939
2	Harold	14092939
3	Diane	55212234
4	Benny	NULL

The Solution

pet_name	owner_id	owner_id	owner_name	telephone
Fluffy	2	1	Gwen	16472939
Buffy	2	2	Bob	14092938
Chirpy	1	3	Diane	55212234
Fang	4	4	Benny	NULL

Meaningless keys are (usually) best.

Diveshop

What is the winter temperature in C° at the place where the customer from Michigan ("MI") booked his vacation?

IN

```
select ... from «some_table»  
where «column» in («values»);
```

```
select name from pet  
where owner in ("Harold",  
"Gwen");
```

Subqueries

```
select ... from «some_table»  
where «column» in («query2»);
```

```
select name from pet  
where owner in  
(select name from owner where  
cc_type="visa");
```



```
select name from
owner where
cc_type="visa";
```

name
Gwen
Harold

```
select name
from pet where
owner in (result);
```

name
Fluffy
Claws
Buffy
Chirpy
Whistler

```
compare with
select name from pet
where owner in ("Gwen",
"Harold");
```

With Comparison

```
select ... from «some_table»  
where «column» < («query2»);
```

```
select name from pet  
where weight < (select  
avg(weight) from pet);
```

“Uncorrelated”

```
select name from pet
where weight < (select
avg(weight) from pet);
```

Inner query is independent from the outer query

“Correlated”

```
select name from pet as p1
where weight < (select
avg(weight) from pet as p2
where p2.species=p1.species);
```

The result of the inner query depends on where we are in the outer query!
(The inner query will need to be evaluated one per row of the outer query.)

“Correlated”

```
select name from pet as p
where weight < (select
average(weight) from pet);
```

Inner query is independent from the outer query

“Correlated”

```
select name from pet
where owner in
(select name from owner where
cc_type="visa");
```

Inner query is independent from the
outer query

Questions?