CS307
Database Principles

Chapter 5

Most contents are from Stéphane Faroult's slides

5.1 Outer Join

Most contents are from Stéphane Faroult's slides

```
select m.year_released, m.title,
       p.first_name, p.surname
from movies m
     join credits c
          on c.movieid = m.movieid
     join people p
          on p.peopleid = c.peopleid
where c.credited_as = 'D'
     and m.country = 'us'
     and year_released = 2018
```

Look for the directors of American movies released in 2018 ...

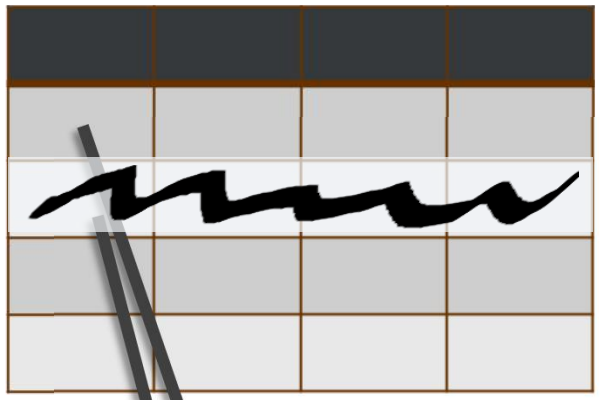
```
 year_released |          title          | first_name |  surname
---------------+-------------------------+------------+-----------
          2018 | Red Sparrow             | Francis    | Lawrence
          2018 | Ready Player One        | Steven     | Spielberg
          2018 | A Star Is Born          | Bradley    | Cooper
          2018 | Mary Queen of Scots     | Josie      | Rourke
(4 rows)
```

```
select m.movieid, m.year_released, m.title
from movies m
where m.country = 'us'
      and year_released = 2018
```

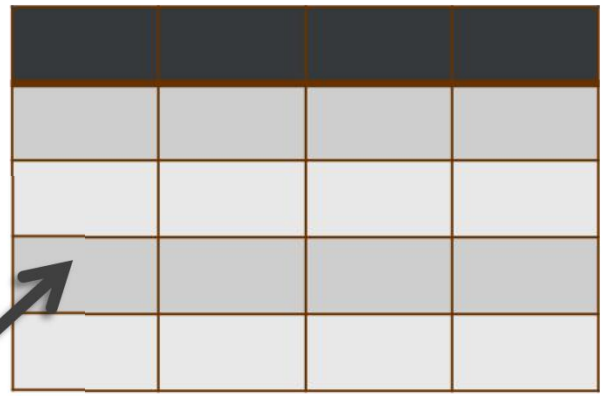
... which is that all movies weren't listed in the previous query. We have for instance 'Black Panter' in the list returned by the query above, and not in the previous one.

```
 movieid | year_released |          title
---------+---------------+-------------------------
    8987 |          2018 | Red Sparrow
    8988 |          2018 | Ready Player One
    8990 |          2018 | A Star Is Born
    8992 |          2018 | Mary Queen of Scots
    9202 |          2018 | Black Panther
    9203 |          2018 | A Wrinkle in Time
(6 rows)
```

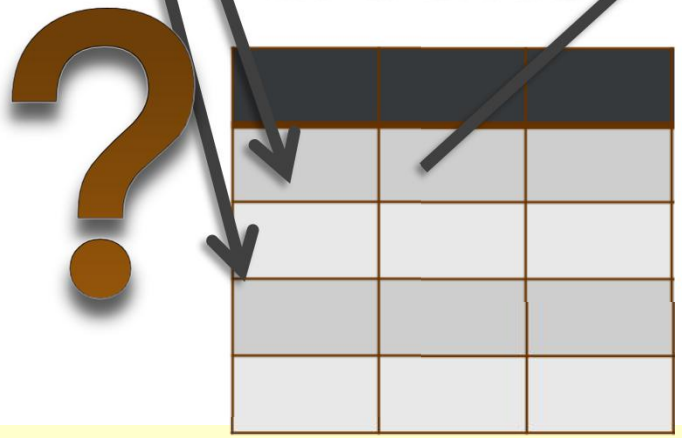
movies



people



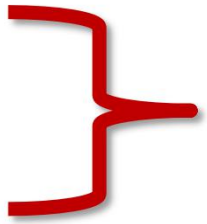
credits



The reason is that its director isn't credited for it in the database. No credits, no link with PEOPLE, the movie vanishes.

```
filmdb=# select * from credits where movieid=9202;
 movieid | peopleid | credited_as
---------+----------+-------------
    9202 |     5588 | A
    9202 |    15870 | A
    9202 |     3933 | A
(3 rows)
```

```
select m.year_released, m.title,
       p.first_name, p.surname
from movies m,
     credits c,
     people p
where c.movieid = m.movieid
  and p.peopleid = c.peopleid
  and c.credited_as = 'D'
  and m.country = 'us'
  and year_released = 2018
```



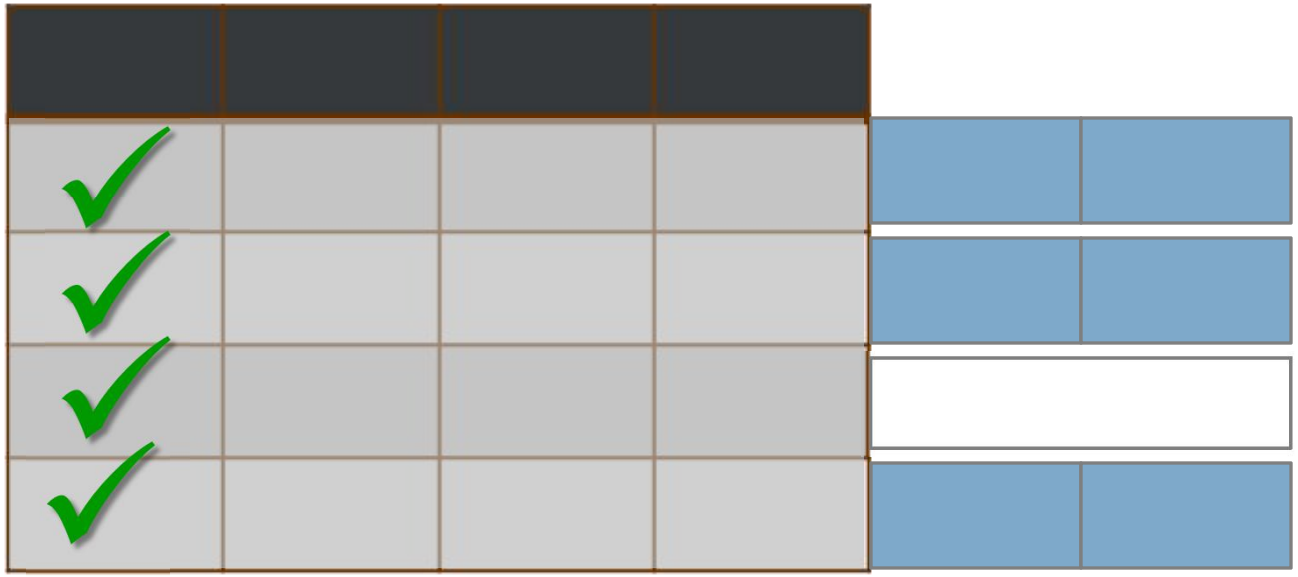
It's easier to understand why with the traditional SQL way of writing joins. Join conditions can also be interpreted as filtering conditions. If we can't find a row in CREDITS, then the condition isn't true.

Flickr: John Wigham

Once again, we have to decide on what we want: are we primarily interested by movies for which the director is known, or by all 2018 American movies?

outer join
inner join

If we want to see all 2018 American movies in the database, we need to resort to an extended kind of join called an OUTER join (the regular join is often called INNER join)



An outer join tells to complete the result set with NULLs if we can't find a match in the outer joined table.

left outer join

right outer join

full outer join

Books always refer to three kinds of outer joins. Only one is useful and we can forget about anything but the LEFT OUTER JOIN. A right outer join can ALWAYS be rewritten as a left outer join. A full outer join is seldom used.

Country Name	Number of movies

Let's take a simpler example than the three-table join between MOVIES, CREDITS and PEOPLE and let's just try to count how many movies we have per country. We may have no movies from smaller countries, or newer countries that haven't produced one movie yet.

```
select c.country_name, x.number_of_movies
from countries c
    inner join
    (select country as country_code,
            count(*) as number_of_movies
     from movies
     group by country) x
        on x.country_code = c.country_code
```

We can start by counting in MOVIES how many movies we have per country. This, of course, will only return countries for which there are movies. If we use an inner join, they will be the only ones we'll see.

country_name	number_of_movies
Algeria	2
Burkina Faso	2
Egypt	11
Ghana	1
Guinea-Bissau	1
Kenya	1
Libya	2
Mali	2
Morocco	2
Namibia	1
Niger	1
Nigeria	49
Senegal	4
South Africa	10
Tunisia	1
Zimbabwe	1
Argentina	38
Bolivia	4
Brazil	38
Canada	82
Chile	14
Colombia	5
Cuba	4
Ecuador	1
Guatemala	1

```
select c.country_name, x.number_of_movies
from countries c
      left outer join
      (select country as country_code,
              count(*) as number_of_movies
       from movies
       group by country) x
          on x.country_code = c.country_code
```

With a left outer join, we'll see all countries in the COUNTRIES table appear. Note that the table that we want to see listed in full (COUNTRIES in that case) is always with a LEFT OUTER JOIN the first one after FROM.

country_name	number_of_movies
Algeria	2
Angola	
Benin	
Botswana	
Burkina Faso	2
Burundi	
Cameroon	
Central African Republic	
Chad	
Comoros	
Congo Brazzaville	
Congo Kinshasa	
Cote d'Ivoire	
Djibouti	
Egypt	11
Equatorial Guinea	
Eritrea	
Ethiopia	
Gabon	
Gambia	
Ghana	1
Guinea	
Guinea-Bissau	1
Kenya	1
Lesotho	
Liberia	
Libya	2

Display zero when we have no movies from a country?

Sometimes with a LEFT OUTER JOIN we don't want to see NULL. NULL is fine with text information (such as a director name) but for quantitative information such as a number of movies we'd rather see zero. This is easy to do.

```
select c.country_name,
       case
         when x.number_of_movies is null then 0
         else x.number_of_movies
       end number_of_movies
from countries c
     left outer join
     (select country as country_code,
             count(*) as number_of_movies
      from movies
      group by country) x
        on x.country_code = c.country_code
```

We can use a CASE construct.

country_name	number_of_movies
Algeria	2
Angola	0
Benin	0
Botswana	0
Burkina Faso	2
Burundi	0
Cameroon	0
Central African Republic	0
Chad	0
Comoros	0
Congo Brazzaville	0
Congo Kinshasa	0
Cote d'Ivoire	0
Djibouti	0
Egypt	11
Equatorial Guinea	0
Eritrea	0
Ethiopia	0
Gabon	0
Gambia	0
Ghana	1
Guinea	0
Guinea-Bissau	1
Kenya	1
Lesotho	0
Liberia	0

```
select c.country_name,
       coalesce(x.number_of_movies, 0)
                        number_of_movies


from countries c
     left outer join
     (select country as country_code,
             count(*) as number_of_movies
      from movies
      group by country) x
          on x.country_code = c.country_code
```

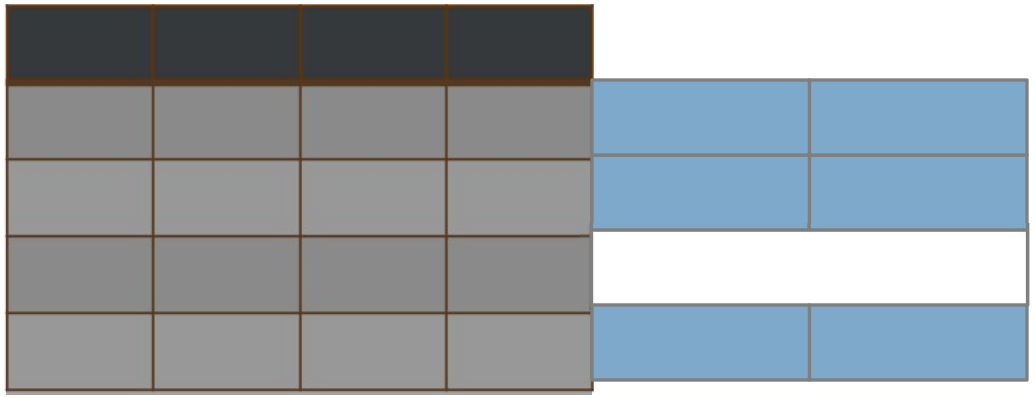
Or we can use the more concise COALESCE() function (available with all products) that takes an indeterminate number of parameters and returns the first one that isn't NULL.

from table1 Œ

left outer join table2

on

❷



Once again, beware that CONTRARY TO WHAT HAPPENS WITH THE ORDINARY (inner) JOIN, ORDER IS IMPORTANT. If you want to see all entries from table1, table1 must come first with a left outer join.

```
select count(*)
from movies m
      inner join countries c
      on m.country = c.country_code
```

```
select count(*)
from movies m
      left outer join countries c
      on m.country = c.country_code
```

```
select count(*)
from movies m
      left outer join countries c
      on m.country <> c.country_code
```

What is the returned number?

Why?

- TRUE
- FALSE
- NULL

British movie titles with director names when available?

But there are other traps with outer joins. Let's try to answer this question again. From the way it is worded, we want to see all British movies, so MOVIES will be the leading table.

```
select m.year_released, m.title,
       p.first_name, p.surname
from movies m
     inner join credits c
        on c.movieid = m.movieid
           inner join people p
              on p.peopleid = c.peopleid
where c.credited_as = 'D'
  and m.country = 'gb'
```

Let's start with the regular, INNER JOIN query that will only show movies for which the director is known. There are different ways to envision it.

```
select a.year_released, a.title,
       a.first_name, a.surname
from (select m.year_released,
             m.title, m.country,
             p.first_name, p.surname,
             c.credited_as
      from movies m
           inner join credits c
             on c.movieid = m.movieid
           inner join people p
             on p.peopleid = c.peopleid) a
where a.credited_as = 'D'
  and a.country = 'gb'
```

We can say that we are building the list of credits for every movie we have

then limit output to directors of British movies.

```
select m.year_released, m.title,
       p.first_name, p.surname
from (select movieid, year_released, title
      from movies
      where country = 'gb') m
     inner join (select movieid, peopleid
                 from credits
                 where credited_as = 'D') c
                on c.movieid = m.movieid
               inner join people p
                          on p.peopleid = c.peopleid
```

Or we can say that we look for British movies

and for directors

then return the names of people for which we find matching movieid values in both lists.

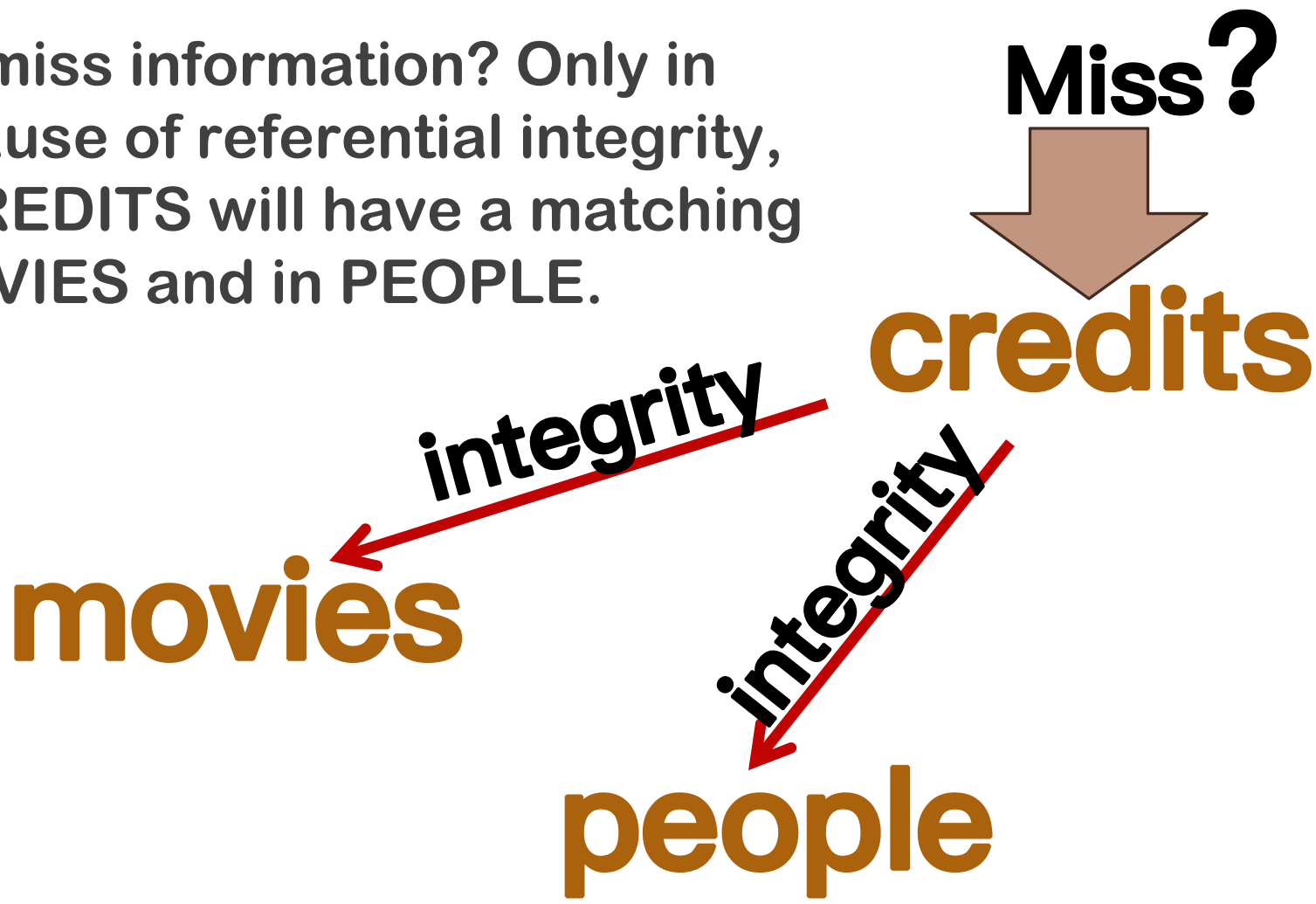
```
select a.year_released, a.title,
       a.first_name, a.surname
from (select m.year_released,
             m.title, m.country,
             p.first_name, p.surname,
             c.credited_as
      from movies m
        inner join credits c
          on c.movieid = m.movieid
        inner join people p
          on p.peopleid = c.peopleid) a
where a.credited_as = 'D'
  and a.country = 'gb'
```

Basically, whether we filter first or last will have (spoiler alert!) some influence on performance, but not on returned data. We should ultimately see the same thing.

As you'll see, it's different with outer joins.

Which table will be fully shown?

Where can we miss information? Only in CREDITS. Because of referential integrity, every row in CREDITS will have a matching row both in MOVIES and in PEOPLE.



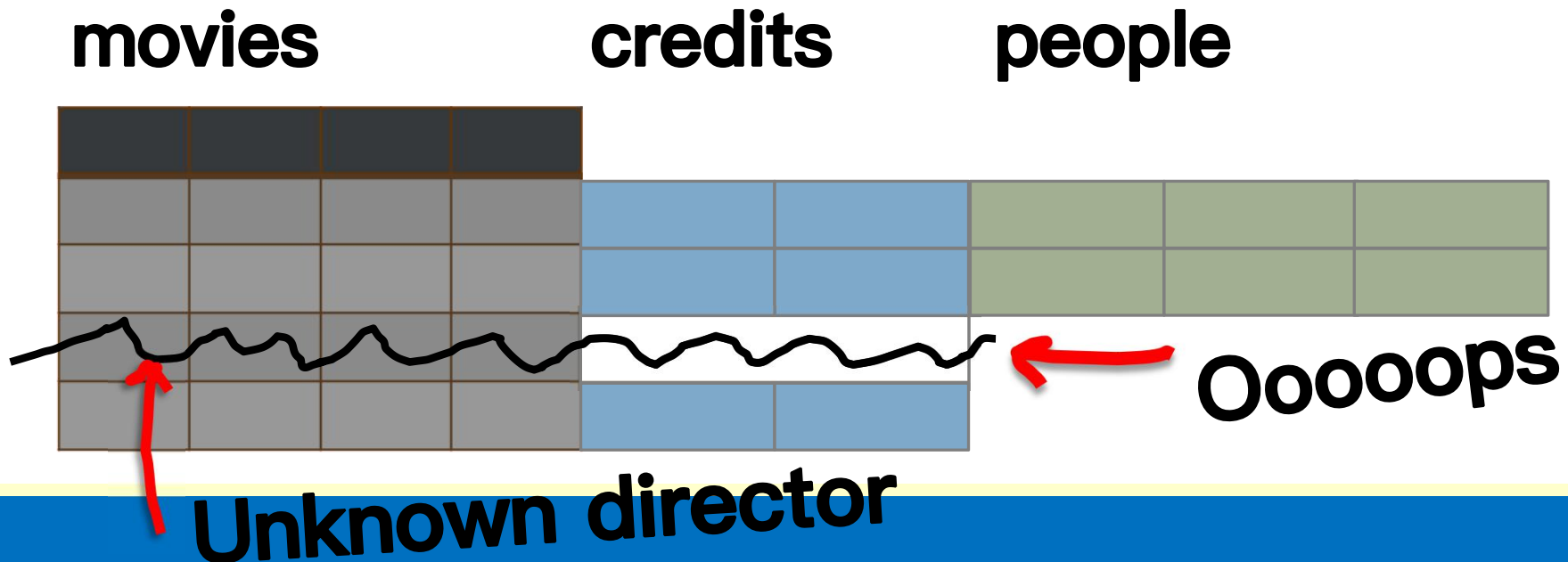
What we may miss are rows in CREDITS, which must be outer joined

```
select m.year_released,
       m.title, m.country,
       p.first_name, p.surname,
       c.credited_as
from movies m
     left outer join credits c
       on c.movieid = m.movieid
      inner join people p
        on p.peopleid = c.peopleid
```

Will our query be correct then? Not yet.

```
from movies m
 left outer join credits c
   on c.movieid = m.movieid
  inner join people p
    on p.peopleid = c.peopleid
```

This condition will fail if we return a NULL row from CREDITS.



```
select a.year_released, a.title,
       a.first_name, a.surname
from (  select m.year_released,
               m.title, m.country,
               p.first_name, p.surname,
               c.credited_as
        from movies m
             left outer join credits c
              on c.movieid = m.movieid
              left outer join people p
              on p.peopleid = c.peopleid
) a
where a.credited_as = 'D'
  and a.country = 'gb'
```

we need a second outer join to return NULL from PEOPLE when there is no row in CREDITS.

← outer join killer

But if the left outer join returns NULL, then CREDITED_AS cannot be 'D' and the movie will disappear.

```
select a.year_released, a.title,
       a.first_name, a.surname
from (select m.year_released,
             m.title, m.country,
             p.first_name, p.surname,
             c.credited_as
      from movies m
           left outer join credits c
             on c.movieid = m.movieid
           left outer join people p
             on p.peopleid = c.peopleid
) a
where (a.credited_as = 'D'
  and a.country = 'gb'
```

or a.credited_as is null)

?

Movies

People

movieid peopleid A

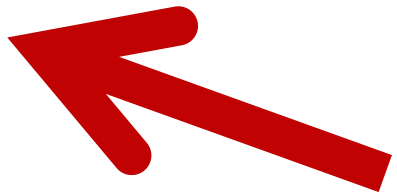
Credits

What is vicious with the previous wrong query is that it will correctly display a movie as long as we know neither director nor actors. As soon as we know one actor (but not the director) the movie will vanish again.

```
select a.year_released, a.title,
       a.first_name, a.surname
from (select m.year_released,
             m.title, m.country,
             p.first_name, p.surname,
             c.credited_as
        from movies m
             left outer join credits c
               on c.movieid = m.movieid
             left outer join people p
               on p.peopleid = c.peopleid
      ) a
where( a.credited_as = 'D'
       or a.credited_as is null)
  and a.country = 'gb'
```

A

Here is why: if we have an actor, the left outer join with CREDITS will behave like an inner join. But it will return 'A' in CREDITED_AS



```
select m.year_released, m.title,
       p.first_name, p.surname
from movies m
     left outer join credits c
          on c.movieid = m.movieid
          left outer join people p
               on p.peopleid = c.peopleid
where (c.credited_as = 'D'
       or c.credited_as is null)
  and m.country = 'gb'
```

Exactly the same thing happens when we haven't all the joins as a subquery, but just a succession of joins followed by a WHERE clause.

The problem was this:

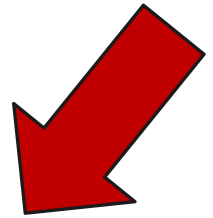
Get movie titles
and director name if available

The query does this:

Get movie titles and people involved, then display if director known or no people found

and it's not exactly the same thing. It only is the same thing when we know the director, or when we know of nobody involved with the movie.

```
select m.year_released, m.title,
        p.first_name, p.surname
from (select movieid, year_released, title
       from movies
       where country = 'gb') m
      inner join (select movieid, peopleid
                  from credits
                  where credited_as = 'D') c
                on c.movieid = m.movieid
              inner join people p
                      on p.peopleid = c.peopleid
```



I have told that with an inner join I could as well first get British movies, then directors. With outer joins this is how I MUST proceed if I want correct results.

```
select m.year_released, m.title,
       p.first_name, p.surname
from (select movieid, year_released, title
      from movies
      where country = 'gb') m
left outer join (select movieid, peopleid
                 from credits
                 where credited_as = 'D') c
    on c.movieid = m.movieid
  left outer join people p
      on p.peopleid = c.peopleid
```

This answers exactly the question asked. It's not necessary to have a subquery of British movies for MOVIES, but it is necessary to have a subquery that only returns directors.

5.2 Filtering and Qualifying

Most contents are from Stéphane Faroult's slides

```
select m.year_released, m.title,
       p.first_name, p.surname
from (select movieid, year_released, title
      from movies
      where country = 'gb') m
left outer join (select movieid, peopleid
                 from credits
                 where credited_as = 'D') c
    on c.movieid = m.movieid
  left outer join people p
      on p.peopleid = c.peopleid
```

Filter close to tables

In other words, with LEFT OUTER JOINs, apply all conditions before joining.

Joins

filtering

qualifying

One thing is interesting with joins, which is that some joins participate in filtering, while others are only here to return additional information that make the result set more legible or intelligible.

```
select m.title, m.year_released
from movies m
  inner join countries c
    on c.country_code = m.country
where c.country_name = '...'
```

Filtering

If I have a condition on the country NAME, then table COUNTRIES kind of drives the query.

```
select m.title, c.country_name
from movies m
  inner join countries c
    on c.country_code = m.country
where m.year_released = ...
```

Qualifying

If the conditions are only on MOVIES and if the only reason for joining on COUNTRIES is to return a name rather than a code, then the join is purely qualifying.

UNLESS

```
select m.title, c.country_name
from movies m
  inner join countries c
    on c.country_code = m.country
where m.date_released = ...
```

Significant?

unless finding a match is significant, because I might find only some values in the other table. With a foreign key constraint, it will never be the case: I'm sure to find the code in COUNTRIES.

```
select distinct
        m.title, c.country_name
from movies m
  inner join countries c
     on c.country_code = m.country
  inner join credits cr
     on cr.movieid = m.movieid
where m.year_released = ...
```

If I had a join with CREDITS, it would become significant: it would implicitly mean "only for movies for which I know some of the people involved".

Outer joins → filtering

is null

qualifying

An outer join is always a qualifying join, unless it is associated with an IS NULL condition, meaning that not finding a match is significant (for instance: countries for which no movie is found in MOVIES)

The real test is: what happens if I remove a join?
Do I have more rows returned or the same number of rows as before?

~~Join~~

MORE rows?

YES → filtering

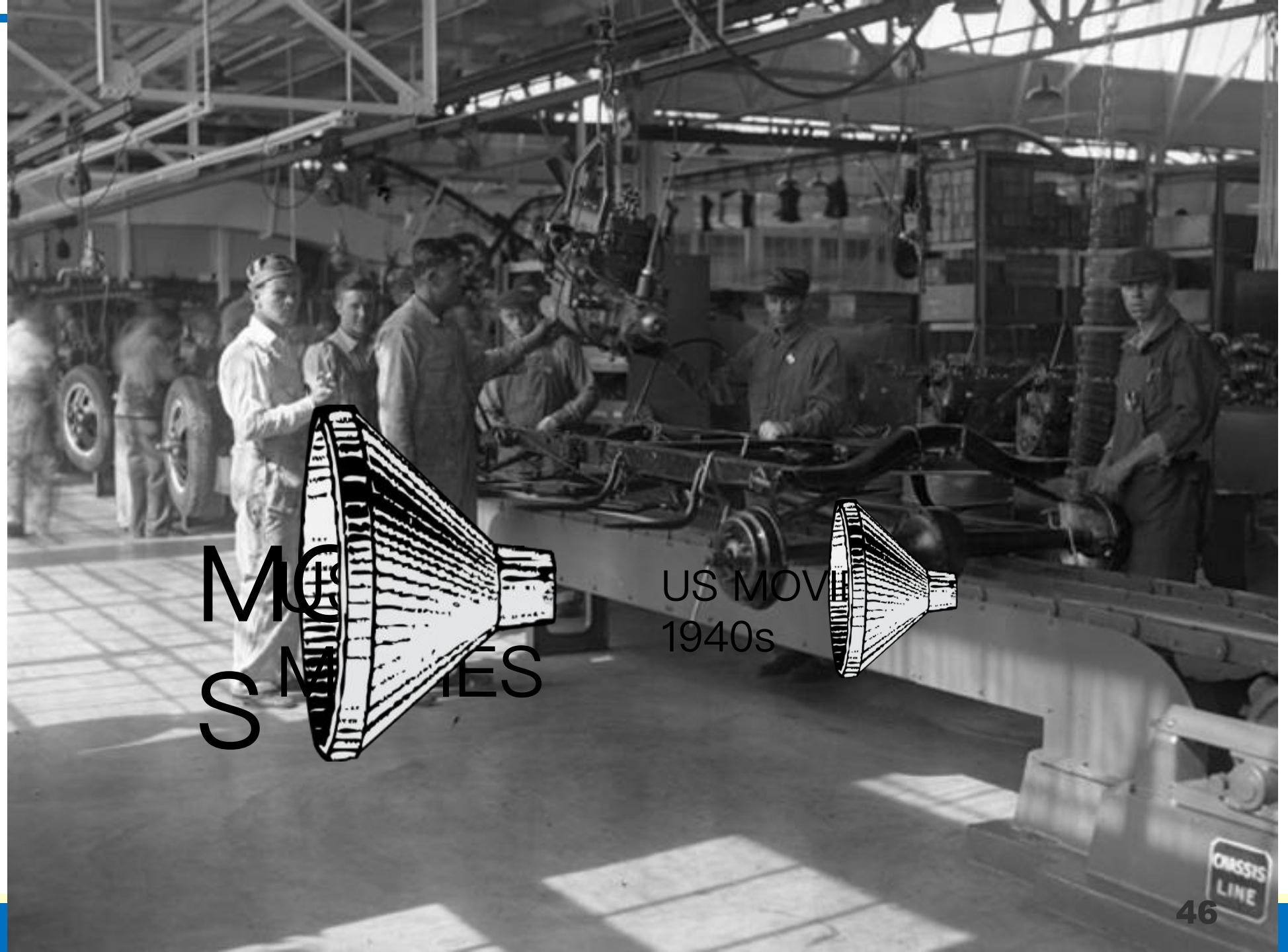
N → qualifying

filtering ASAP

Performance-wise it makes no sense to run a join on rows that will be discarded. Keep qualifying joins for the end.

qualifying later

Apply filtering as soon as possible to reduce the number of rows to process

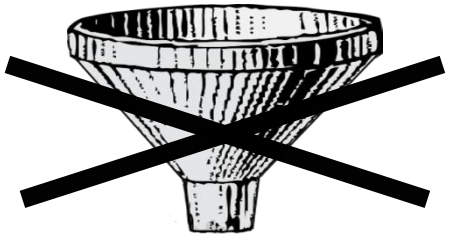

MOVIES
US MOVIES
1940s
OMNIBUS LINE

```
select *
from movies
where country_code = 'us'
  and year_released between 1940 and 1949
```

In particular, I have said that conditions linked by AND were like successive refining of result sets through successive queries.

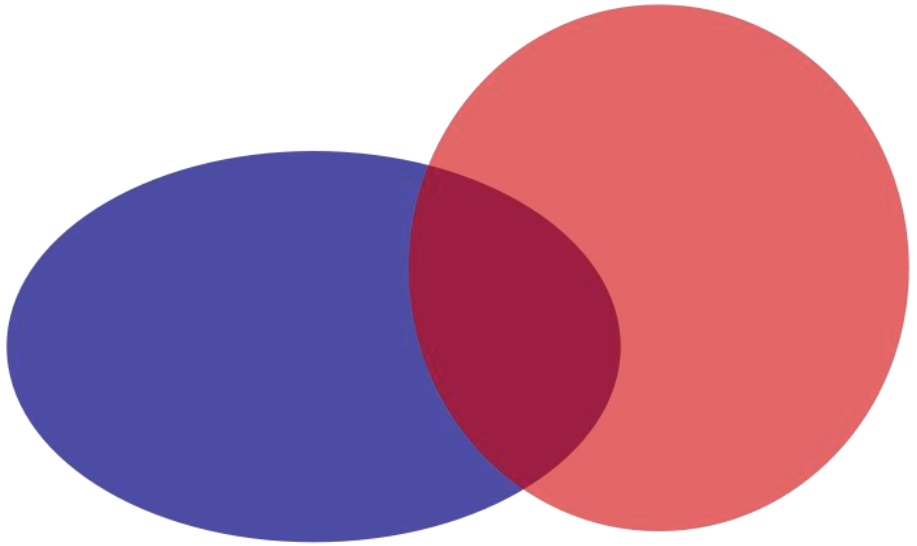
```
select *
from (select *
      from movies
      where country_code = 'us') us_movies
where year_released between 1940 and 1949
```

```
select *
from movies
where country_code = 'us'
  and year_released between 1940 and 1949
```



What I didn't say, though, is that this isn't true with OR. With OR, each new condition potentially adds MORE rows.

```
select * from movies
where (country = 'us'
       or country = 'gb')
  and year_released between 1940 and 1949
```



5.2 Set Operators

Most contents are from Stéphane Faroult's slides

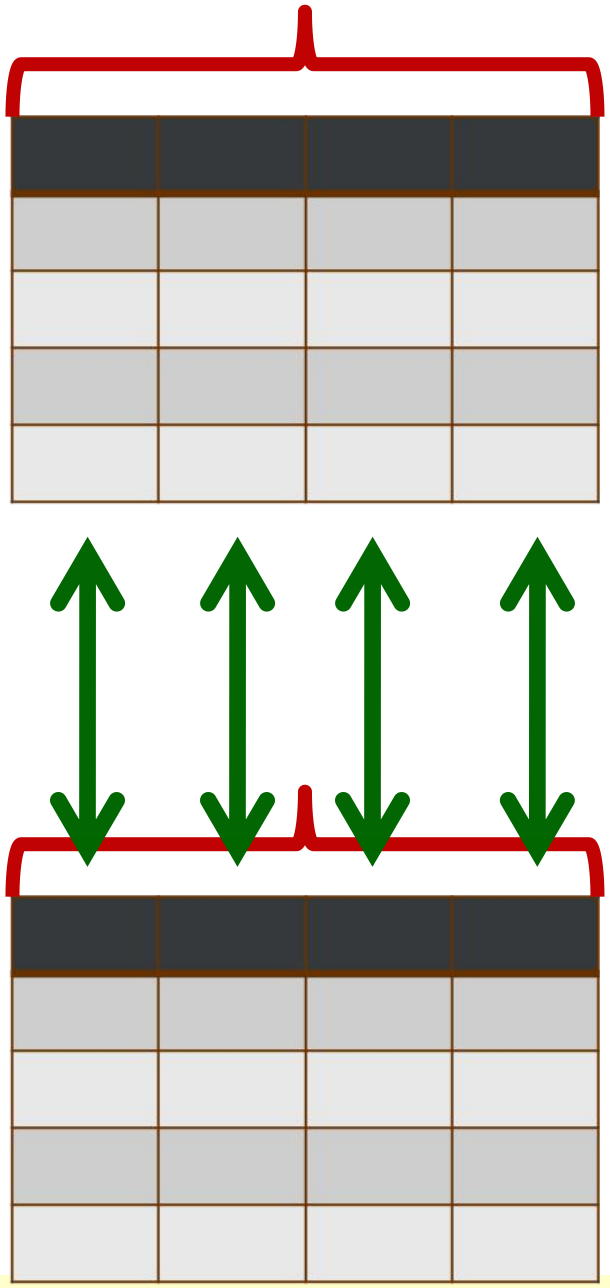
UNION

The most important (by far) set operator is UNION that takes two result sets and combines them into a single result set.

US and GB movies, 1940s

```
select movieid, title, year_released, country
from movies
where country = 'us'
  and year_released between 1940 and 1949
union
select movieid, title, year_released, country
from movies
where country = 'gb'
  and year_released between 1940 and 1949
```

For instance we could combine American movies of the 1940s with British movies of the 1940s (OR would be more efficient than two separate searches)



UNION requires two commonsensical conditions: to combine the results of two queries, they must return the same number of columns, and the data types of corresponding columns must match.

Imagine that you are managing a website that sells subscriptions for movies, with a "standard" subscription and a more expensive "premium" subscription that gives access to more recent movies stored in another table (not necessarily the best of designs, but it's another question)

movies

premium_movies

You want to display to your "premium" subscribers the content of BOTH tables at once, which you will do with UNION.

```
select 'regular' as class,
        movieid,
        title,
        year_released
from movies
union
select 'premium' as class,
        movieid,
        title,
        year_released
from premium_movies
```

We are going to return with a UNION data from both table. One thing that you need to know is that UNION eliminates duplicates because when you put two duplicate-free relations together, nothing guarantees that you won't have duplicates, except when you have different constants like here.

```
select 'regular' as class,
        movieid,
        title,
        year_released
from movies
union    all
select 'premium' as class,
        movieid,
        title,
        year_released
from premium_movies
```

When you know that you CANNOT have duplicates, then you don't need to go through the step of duplicate removal, which is costly. In that case, instead of saying UNION, you say UNION ALL.UNION ALL doesn't mean that you want duplicates, it means that you know that there cannot be any duplicates between the two queries.

Last year's views plus year-to-date views

Sometimes you NEED to add ALL to UNION. Suppose that you have two tables, one that stores all the views of your movies last year (for reference) and one with all the views for the current year, and you want to sum them both.

```
select x.movieid,
       sum(x.view_count) as view_count
from
( select movieid,
         sum(view_count) as view_count
  from last_year_data
  group by movieid
  union
  select movieid,
         sum(view_count) as view_count
  from current_year_data
  group by movieid
) x
group by x.movieid
```

Goodfellas

2,35

Goodfellas

2,35

It may happen that last year's count is EXACTLY this year's count.

Goodfellas	2356

union

Goodfellas	2356

If this is the case, UNION will see a duplicate, and will remove one of the rows. Result, counts will be correct for almost all movies, except this one if this is the only one in this situation, for which it will be half what it should be! Very difficult to notice that the result is wrong.

Goodfellas	2356

union all

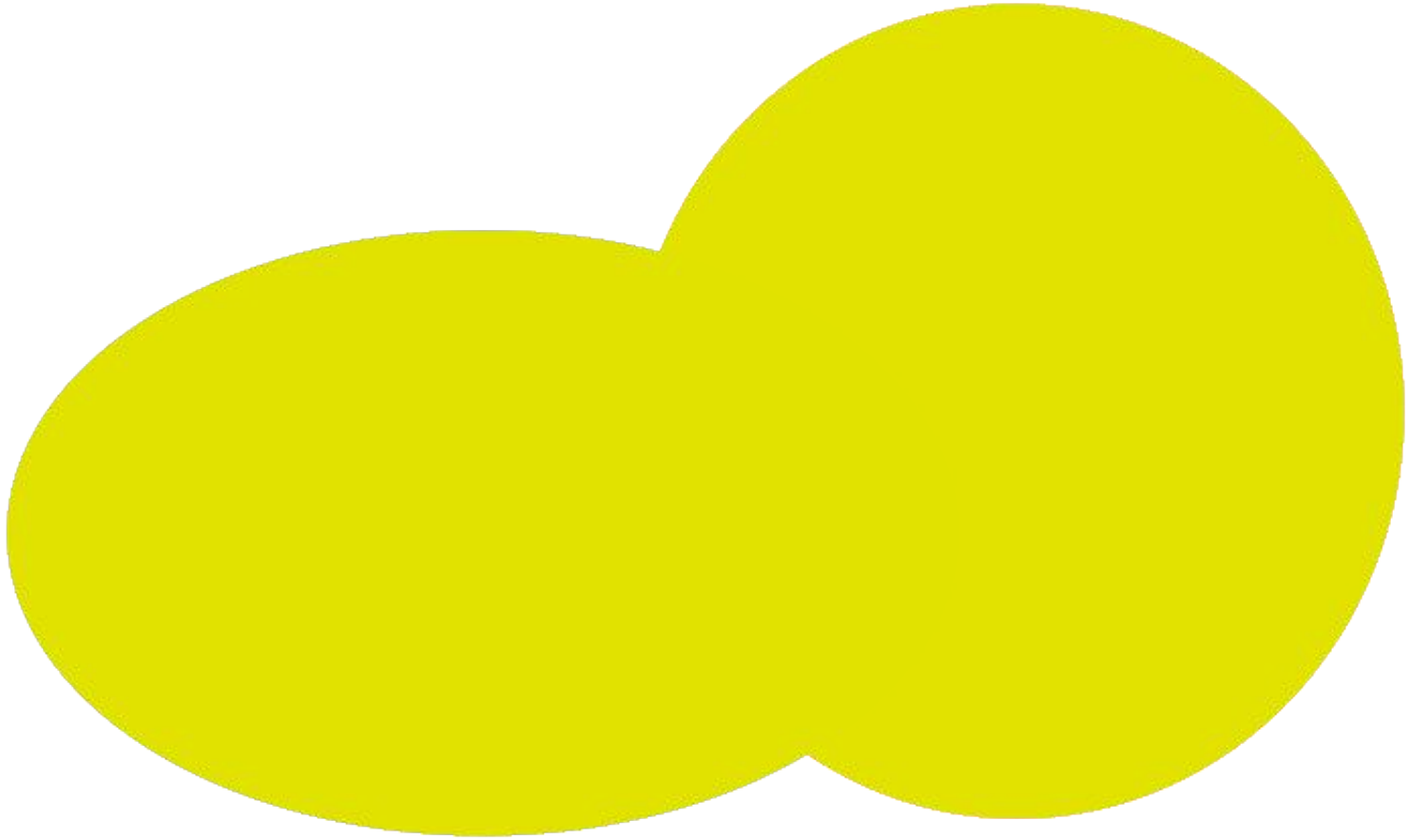
Goodfellas	2356

In fact, it may be a "technical duplicate", but it's not a "real duplicate" because both rows represent completely different things, counts for two different years that happen, by mishap, to be identical. We need UNION ALL.

```
select x.movieid,
       sum(x.view_count) as view_count
from (select 'last year' as period,
             movieid,
             sum(view_count) as view_count
      from last_year_data
      group by movieid
      union all
      select 'this year' as period,
             movieid,
             sum(view_count) as view_count
      from current_year_data
      group by movieid) x
group by x.movieid
```

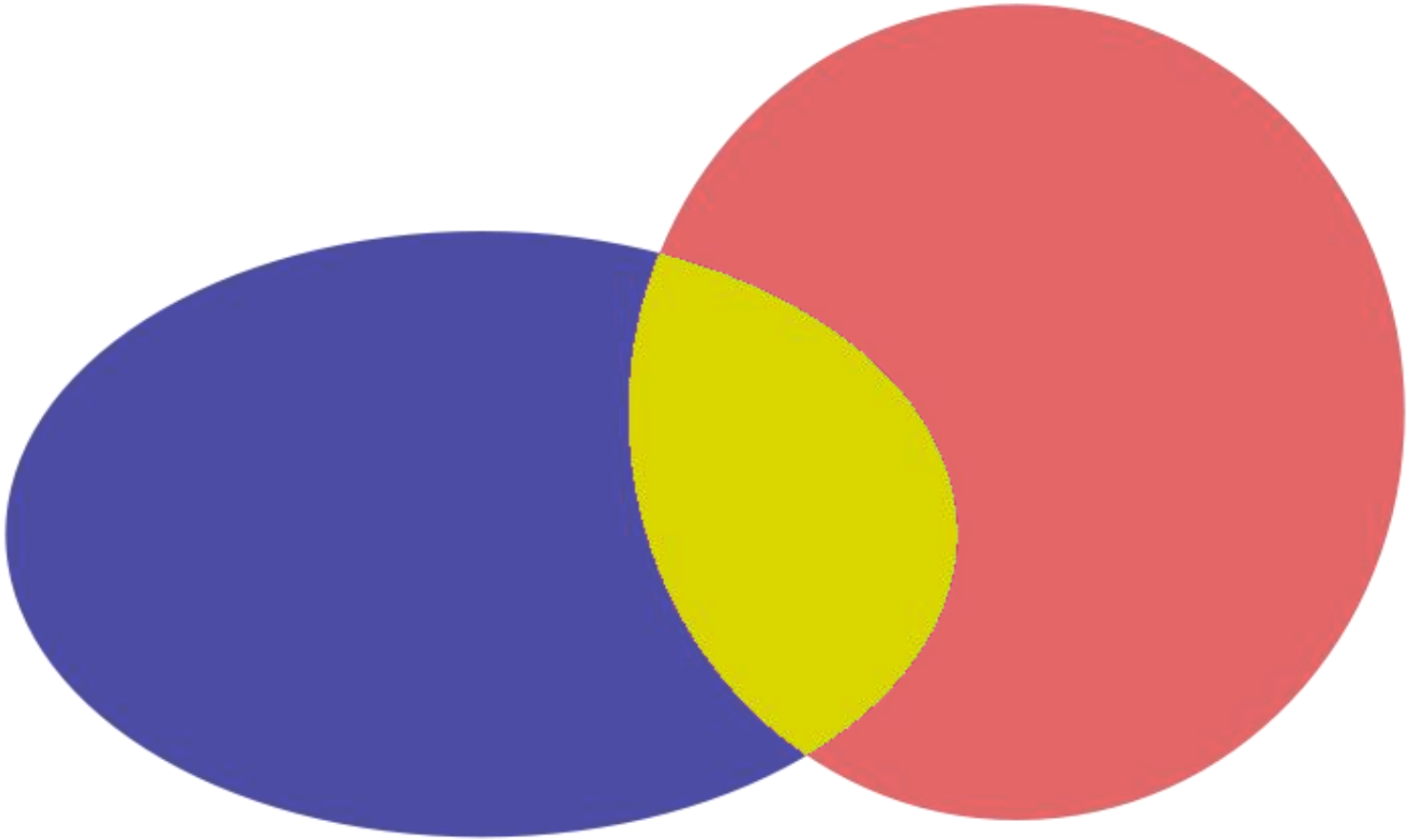
In such a case, I like to add a constant that documents that we are talking about different things and justifies using UNION ALL.

union



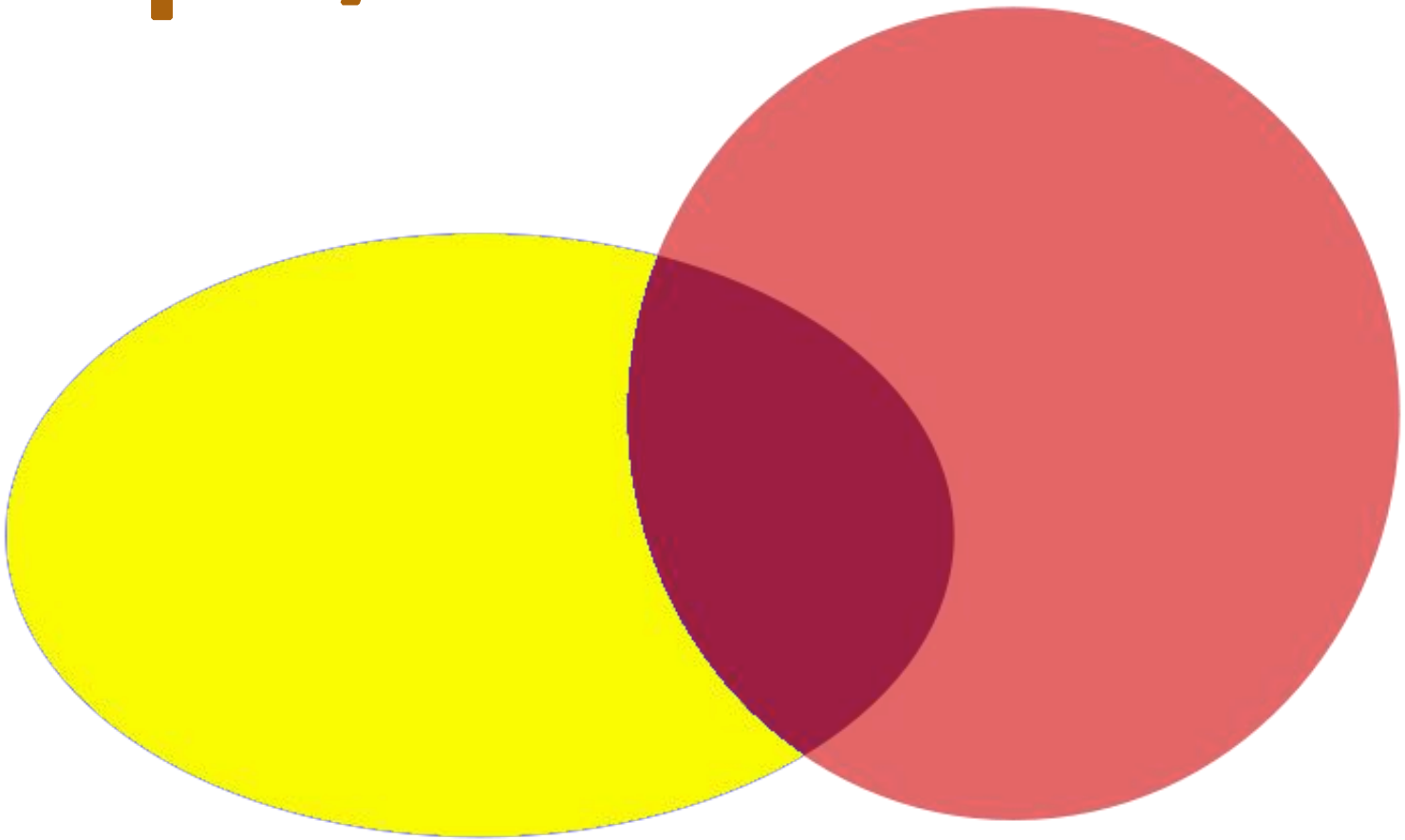
UNION is the most used set operator. It's not the only one.

intersect



It returns the common rows in two tables (or query results)

except / minus



EXCEPT, called MINUS in Oracle, is the last one. It returns the rows from the first table, minus those that can also be found in the second table.

intersect → inner join

except → outer join

If they aren't used as much as UNION, it's because contrary to them UNION provides a functionality unavailable otherwise. Finding common rows can be performed with a simple JOIN. Rows present in one set and absent from another can be found with an outer join and an IS NULL condition on a mandatory column of the second table to specify that no match was found.

country codes that are both in

movies and **countries**

Let's take an example and find country codes that are both in MOVIES and in COUNTRIES.

```
select country_code
from countries
intersect
select distinct country_code
from movies
```

We could use INTERSECT. Like UNION it removes duplicates but it's sounder (and more efficient) to eliminate them as soon as possible with a DISTINCT.

```
select c.country_code
from countries c
     inner join
        (select distinct country
         from movies) m
      on m.country = c.country_code
```

Or we can join, as the join will eliminate every country code from COUNTRIES that cannot be found in MOVIES.

Except of course that as we have a foreign key relationship between MOVIES and COUNTRIES and that we CANNOT have a code in MOVIES that isn't in COUNTRIES, all we need to do is collect the different country codes we find in MOVIES.

```
select distinct country
from movies
```

Important performance lesson: never do something that isn't required. The join and the intersect were doing work for nothing.

Different problem:

Countries for which we haven't any movie.

Finding countries for which we have no movie, though, requires both COUNTRIES and MOVIES. There are two ways to answer the question.

or
minus

```
select country_code
from countries
except
select distinct country
from movies
```

```
select c.country_code
from countries c
      left outer join
          (select distinct country
           from movies) m
        on m.country = c.country_code
where m.country is null
```

Or a LEFT OUTER JOIN and a condition IS NULL on a column that cannot be null, which proves that it was returned by the LEFT OUTER JOIN because no match was found.

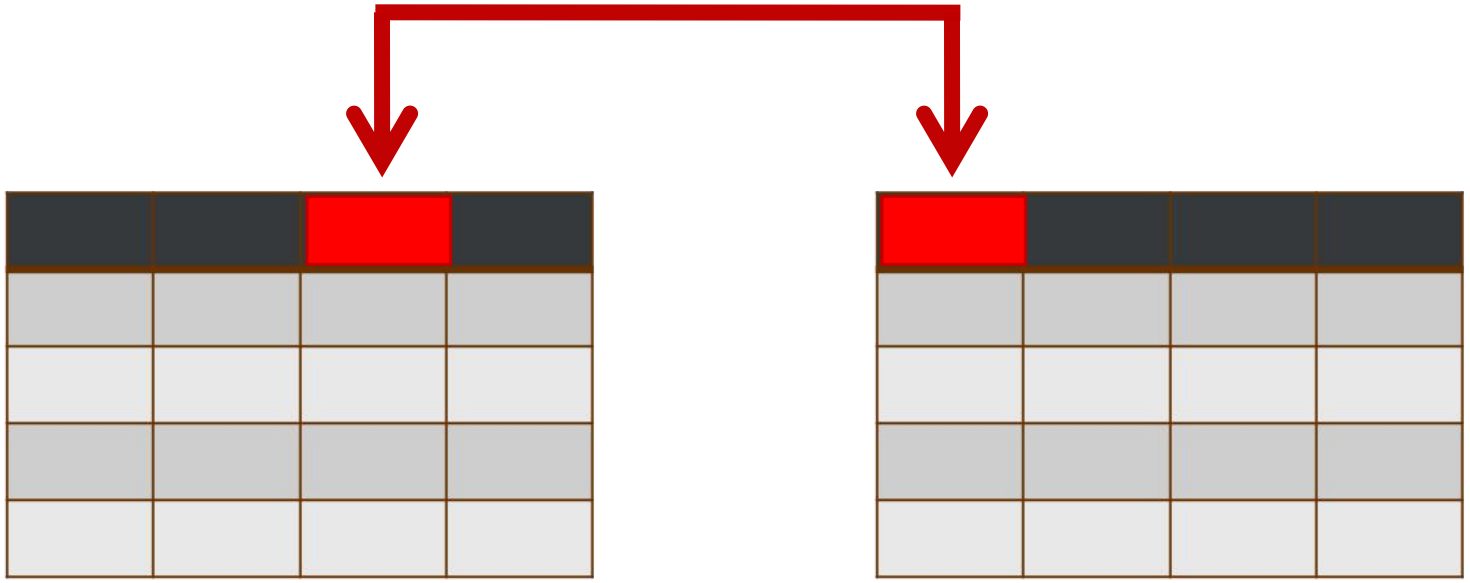
Equivalent columns

In practice, the fact that we must have the same number and types of columns with set operators is fairly constraining.

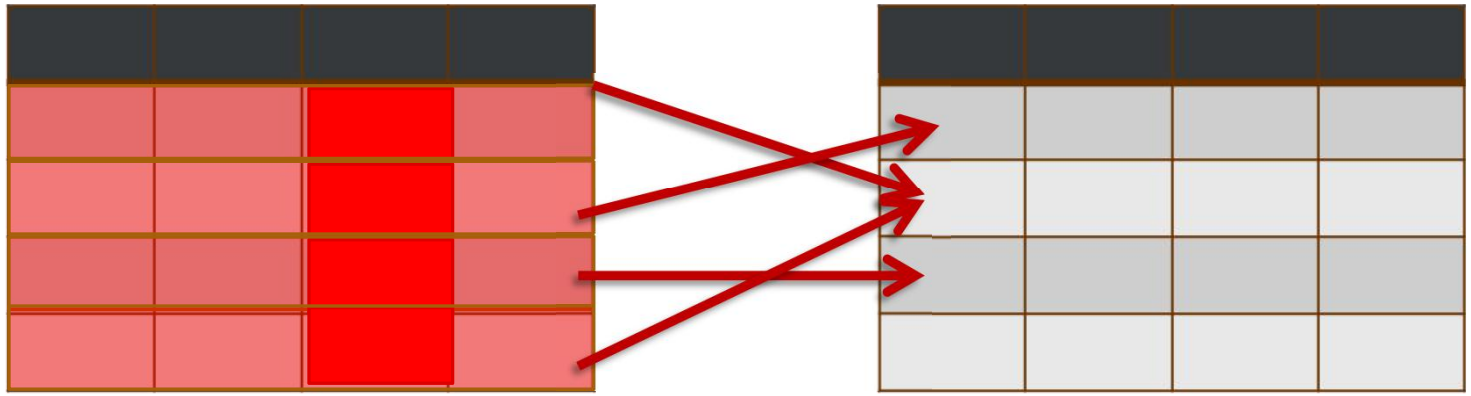
Flickr: Tomáš Obšívač

5.3 Subqueries

Most contents are from Stéphane Faroult's slides



When you run a join, you link tables through common values in one (sometimes several) column.



One way to perform a join, known as a "nested loop" (there are other algorithms) is to scan a table and for each row look for matching values in the column of the other table on which the join is performed.

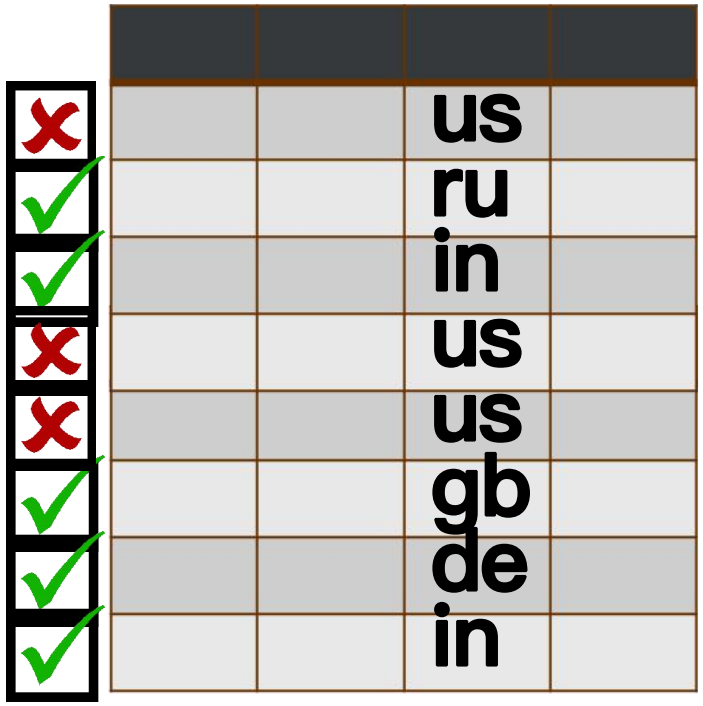
```
select m.title, m.year_released,
       c.country_name
from movies m
     join countries c
       on c.country_code = m.country
where m.country <> 'us'
```

So you can imagine that when you execute this join, for every row in MOVIES the code in column COUNTRY will be checked, and, if it's not 'us', the corresponding movie title, year_realeased and country name will be fetched from COUNTRIES.

You could also write the query like this, with a subquery after the SELECT.

```
select m.title, m.year_released,
       (select c.country_name
        from countries c
        where c.country_code = m.country)
              as country_name
from movies m
where m.country <> 'us'
```

The condition in the subquery is provided by the value in the row from MOVIES that is currently inspected. The subquery is said to be CORRELATED with the outer (main) query.




```
select c.country_name
from countries c
where c.country_code = 'ru'
```

```
select c.country_name
from countries c
where c.country_code = 'in'
```

```
select c.country_name
from countries c
where c.country_code = 'gb'
```

```
select c.country_name
from countries c
where c.country_code = 'de'
```

```
select c.country_name
from countries c
where c.country_code = 'in'
```

The subquery is fired for every returned row.

Note though that this isn't exactly equivalent to a join.
What happens if we don't find the country name?
(which won't happen here because of the foreign key)

```
select m.title,
       (select c.country_name
        from countries c
        where c.country_code = m.country)
                as country_name
from movies m
where m.country_code <> 'us'
```

The subquery would return nothing, also known as NULL.

```
select m.title,
       c.country_name
from movies m
     left outer join countries c
          on c.country_code = m.country
where m.country <> 'us'
```

So, strictly speaking, a subquery after the SELECT is more equivalent to a LEFT OUTER JOIN.

a subquery in the FROM cannot be correlated.

from clause

a subquery after SELECT usually is

select list

where clause

a subquery after WHERE usually is.

in (..., ..., ...)

```
select country, title
from movies
where country in ('us', 'gb')
  and year_released between 1940
                        and 1949
```

IN () is a nice alternative way to replace a series of conditions on the same column linked by OR.

```
in (select col
    from ...
    where ...)
```

But IN () is far more powerful than this, because what is between parentheses may be, not only an explicit list, but also an implicit list of values generated by a query.

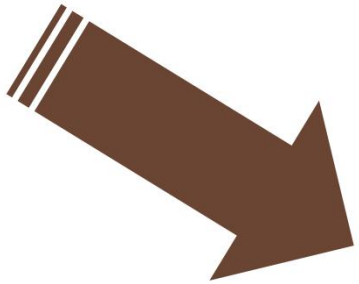
```
select country, year_released, title
from movies
where country in
        (select country_code
         from countries
         where continent = 'EUROPE')
```

For instance, this query would return every European movie without having to painfully list all European countries.

```
(col1, col2) in
        (select col3, col4
         from t
         where ...)
```

Some products (Oracle, DB2, PostgreSQL with some twisting) even allow comparing a set of column values (the correct word is "tuple") to the result of a subquery.

in



distinct

One thing important to know is that IN () means an implicit DISTINCT in the subquery. I always prefer to make the implicit explicit, but some people disagree.

```
select country, year_released, title
from movies
where country in
        (select country_code
         from countries
         where continent = 'EUROPE')
```

Actually, such a subquery is, as you see, not correlated: it doesn't depend on the outside query. In fact, the subquery could be moved up in the FROM clause.

```
select m.country, m.year_released, m.title
from movies m
     inner join
       (select country_code
        from countries
        where continent = 'EUROPE') c
       on c.country_code = m.country
```

Unique?

But if you do so, then the JOIN is a relational operation that should only be performed between two relations – is what I return in my subquery unique? In that case yes, as it's the primary key.

Demonstrably no unique distinct

If I am sure that what I return can only be unique (because I return either a primary key or unique constraint, plus possibly other columns) I shouldn't have DISTINCT, which will just add costly and unnecessary processing.

```
select country, title
from ...
      inner join
         (select distinct ...
          from ...)
         on ...


where col in
     (select distinct ...
      from ... )
```

But, if there is the shadow of a possibility, however remote, that one day I might have duplicates (in other words, if I haven't the guarantee of a constraint), then I should have DISTINCT otherwise I may have wrong results with a JOIN (although not with a IN (), but I prefer documenting the possibility of a problem)

Explicit

is better than

Implicit

Duplicate rows? Checked.

duplicate rows?

The other source of problems in SQL is null

null?

and you probably won't be disappointed.

```
col in ('a', 'b', 'c')
```

=

```
(col = 'a'
 or col = 'b'
 or col = 'c')
```

We have seen that an IN () is equivalent to a series of OR conditions

Throw a NULL in, we have a condition that is never true but because of OR it can just be ignored.

```
col in ('a', 'b', null)
```

=

```
(col = 'a'
 or col = 'b'
 or col = null)
```

never **true**

```
col not in
    ('a', 'b', null)

        =

(col <> 'a'
 and col <> 'b'
 and col <> null)
```

never
true

```
select *
from people
where first_name not in
    (select first_name
     from people
     where born < 1950)
```

```
filmdb=# select *
from people
where first_name not in
    (select first_name
     from people
     where born < 1950)
;
 peopleid | first_name | surname |
----------+------------+---------+
(0 rows)
```

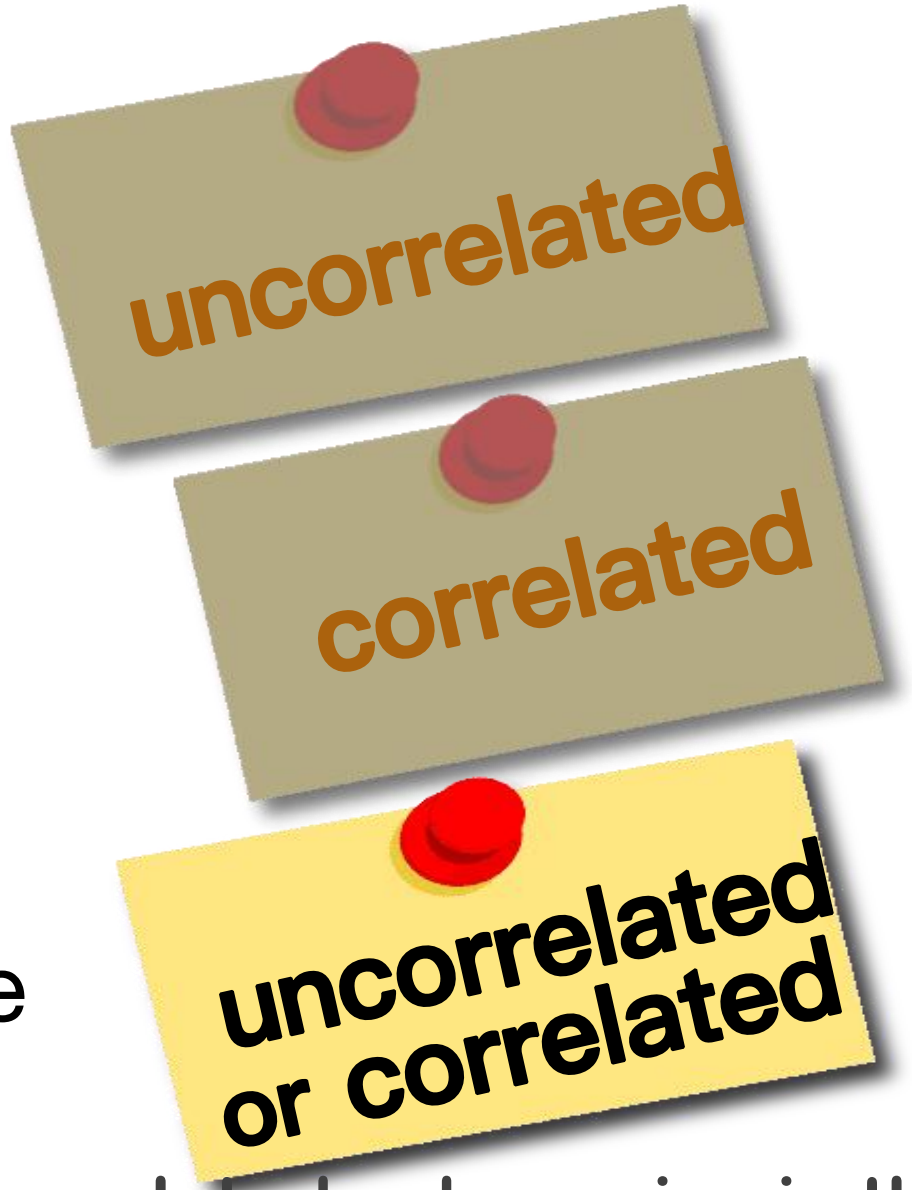
A subquery that returns a NULL in a NOT IN () will always give a null condition, and the result will vanish. That's what happened with Arletty, born long before 1970. If you want to be safe, you should add a condition saying that you DON'T WANT null values if they are possible.

```
select *
from people
where first_name not in
    (select first_name
     from people
     where born < 1950
       and first_name is not null)
```

from clause

select list

where clause



So far we have only seen uncorrelated subqueries in the WHERE clause.

exists

not exists

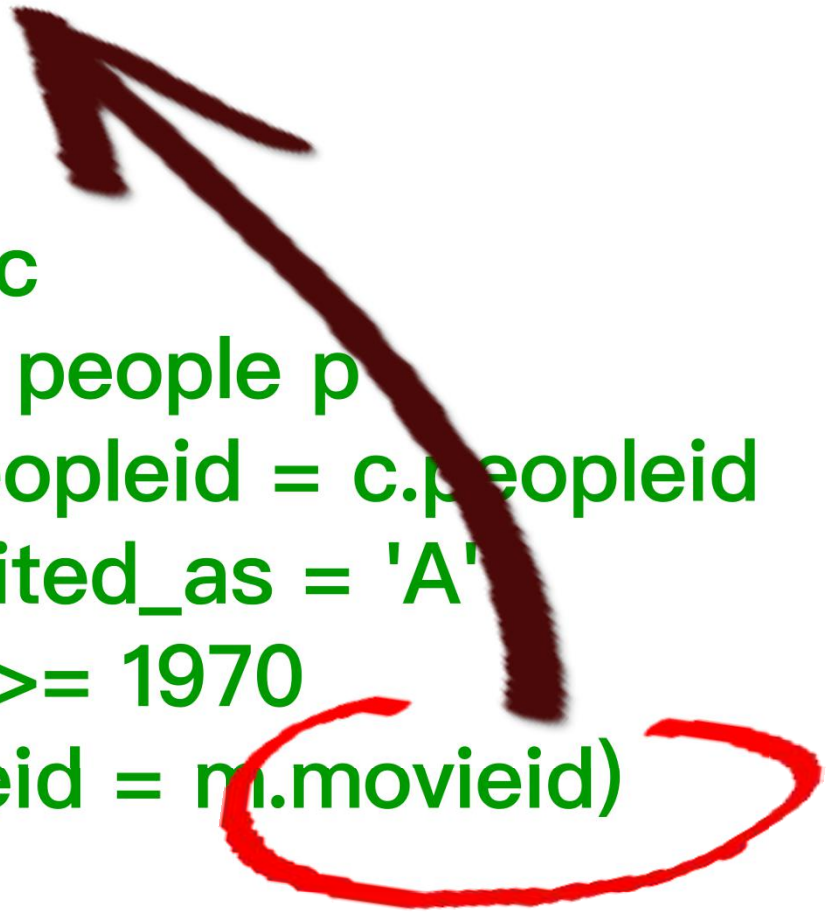
Correlated queries in the WHERE clause are used with the (NOT) EXISTS construct.

NEVER try to correlate an IN()!

```
and exists
   (select ...
   ...)
```

In an EXISTS I have, as with subqueries after a SELECT, a reference to a value from the current row of the outer query.

```
select distinct m.title
from movies m
where exists
 (select null
  from credits c
       inner join people p
           on p.peopleid = c.peopleid
  where c.credited_as = 'A'
    and p.born >= 1970
    and c.movieid = m.movieid)
```



For instance the movies with at least one actor born in 1970 or later.

And I've used that scary null.

```
select
null
```

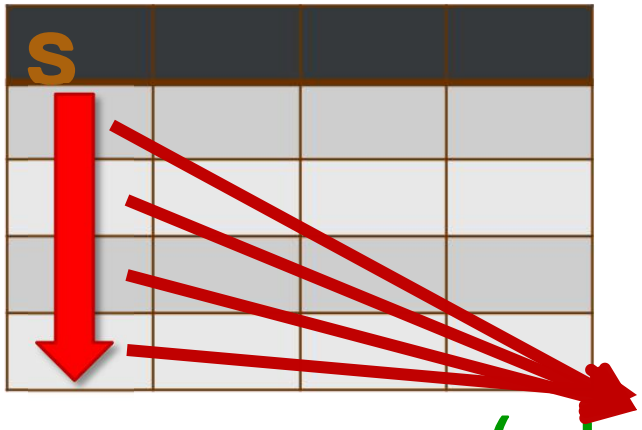
Flickr: Kevin N. Murphy

```
select m.title
from movies m
where exists
 (select 'hello'
  from credits c
       inner join people p
           on p.peopleid = c.peopleid
  where c.credited_as = 'A'
    and p.born >= 1970
    and c.movieid = m.movieid)
```

In fact I could have used anything, and NULL emphasizes it.

I'm not interested in whom, or when precisely they were born. I just want to check that there is such a person.

movie

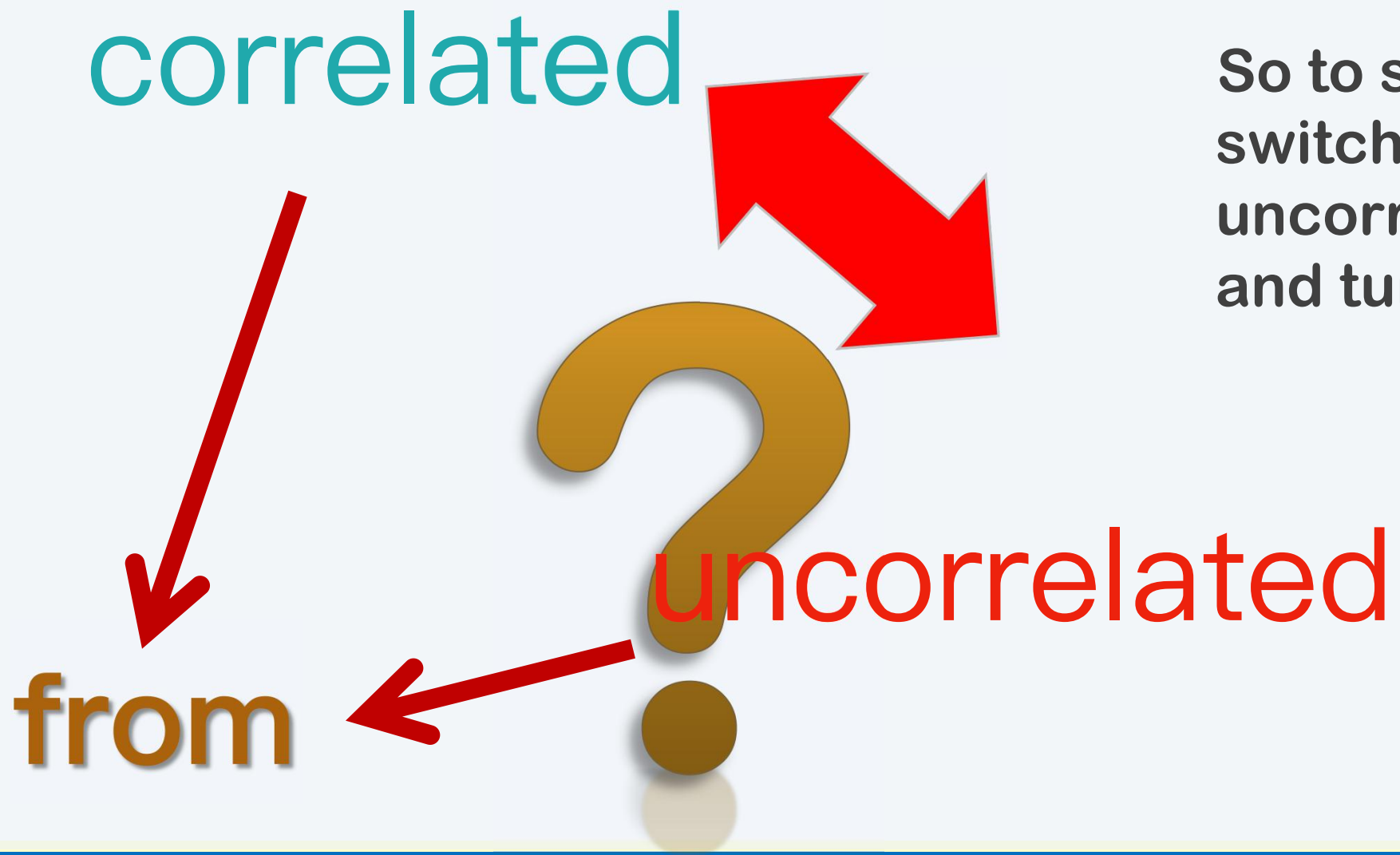


I'm going to inspect every movie, and look among actors each time whether there was someone born in or after 1970. Good on few rows, bad on a large number of rows.

```
(select null
 from credits c
      inner join people p
         on p.peopleid = c.peopleid
 where c.credited_as = 'A'
   and p.born >= 1970
   and c.movieid = current movieid)
```

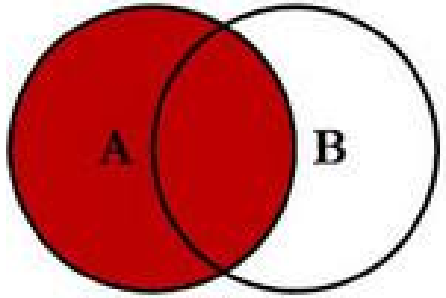
```
select distinct m.title
from movies m
where m.movieid in
   (select distinct c.movieid
    from credits c
         inner join people p
           on p.peopleid = c.peopleid
    where c.credited_as = 'A'
      and p.born >= 1970)
```

In fact I could turn the query into one with an uncorrelated subquery, executed only once, that returns all movies with at least one actor born in 1970 or later.

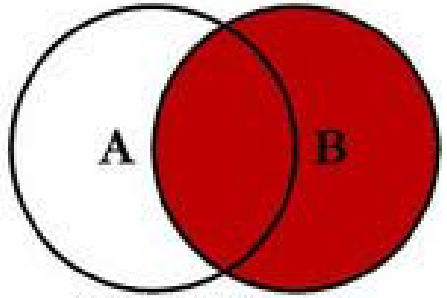


So to summarize we can switch correlated and uncorrelated subqueries, and turn them into joins.

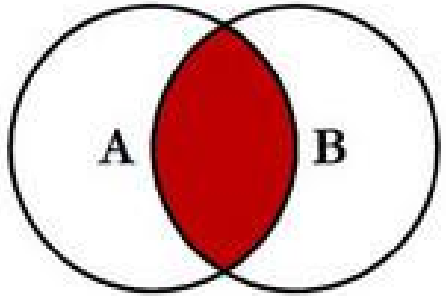
SQL JOINS



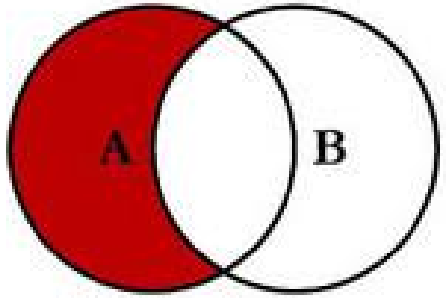

```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
ON A.Key = B.Key
```



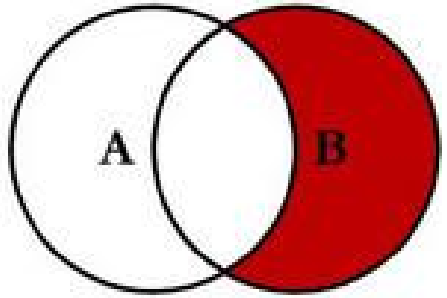

```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
ON A.Key = B.Key
```



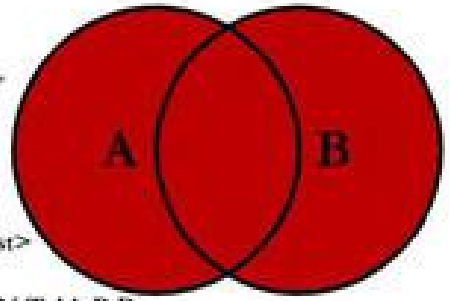

```
SELECT <select_list>
FROM TableA A
INNER JOIN TableB B
ON A.Key = B.Key
```



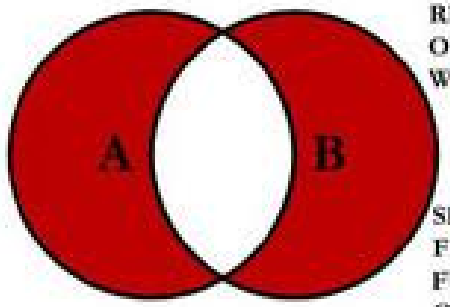

```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
ON A.Key = B.Key
WHERE B.Key IS NULL
```




```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
ON A.Key = B.Key
WHERE A.Key IS NULL
```



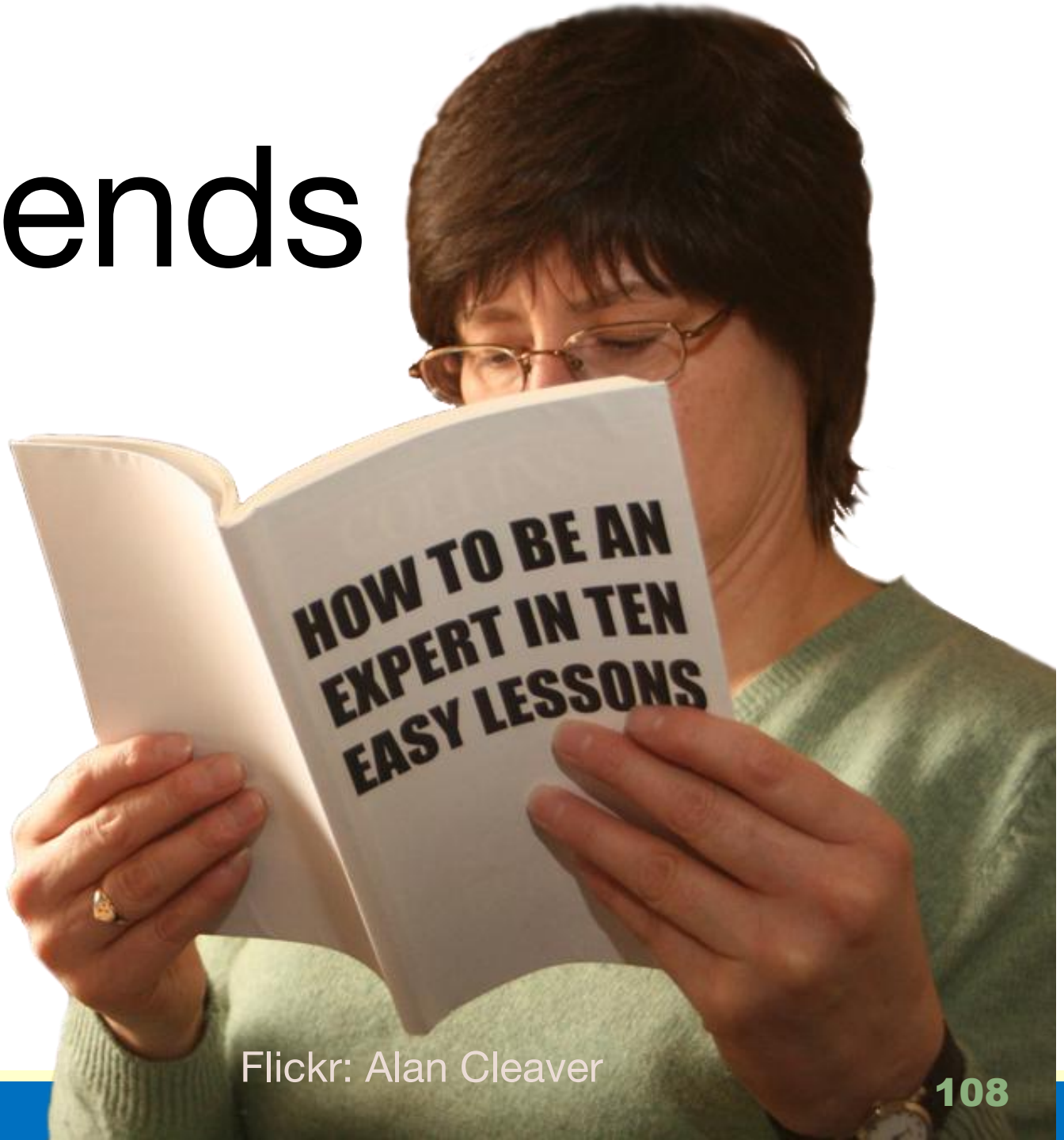

```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
ON A.Key = B.Key
```




```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
ON A.Key = B.Key
WHERE A.Key IS NULL
OR B.Key IS NULL
```

It depends

A bit too soon to discuss it now, but we'll talk about it when we come to performance issues.



Flickr: Alan Cleaver

Joins on common values.

- Inner: match only
- Outer: complete with nulls

Joins on common values.

- Inner: match only
- Outer: complete with nulls

Order of tables and place of conditions matter with outer joins, not with inner joins.

Joins on common values.

- Inner: match only
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Order of tables and place of conditions matter with outer joins, not with inner joins.

Set operators also allow to combine datasets. Only UNION provides functionality that no operator provide.

Joins on common values.

- Inner: match only
- Outer: complete with nulls

Order of tables and place of conditions matter with outer joins, not with inner joins.

Set operators also allow to combine datasets. Only UNION provides functionality that no operator provide.

Subqueries can appear in the SELECT (correlated), in the FROM (uncorrelated), in the WHERE (either). Beware of nulls.