7. SQL – Data Handling

7.1 The query language SQL
- Search predicates
- Arithmetic expressions and functions in predicates
- Different kinds of join
- Output layout

7.2 Advanced SQL
- Subselects and Correlated subqueries
- Quantified expressions, SOME, ANY
- Grouping and Aggregation
- Transitive closure

7.3 Update, Deletion, Insertion and bulk load*

Lit.: Melton / Simon, Understanding SQP 1999, chap. 2,5,7; Kemper / Eickler chap 4,
SQL chapter in any book on DBS

(*) chap.6. Calculus Language: not discussed in class

SQL / DML: Overview

Query data
- Interactively
- Embedded in host language
  important in applications, next chapter

Insert, update, delete data

7.1 The Query Language SQL

SQL is relational complete
...but many additional query concepts compared to RA

Advanced search predicates on strings
e.g., find all cities starting with "Ber"

Arithmetics in expressions,
e.g., GNP / population for all countries

Grouping and predicates over sets
e.g., total GNP of EU countries

Recursion

Simple SQL Search predicates

Defined like Boolean predicates in RA and Calculus
Some syntax extensions

- `<attribute> BETWEEN <value1> AND <value2>`
- `<attribute> IS [NOT] NULL`

```
SELECT *
FROM Country
WHERE population  BETWEEN 50000000 AND 70000000
AND GNP IS NOT NULL
```

Simple SQL Search expressions

Simplified OR

```
SELECT Name
FROM Country
WHERE C_ID IN ('BRD','D','DDR')
```

Equivalent to
`<attr> = <val1> OR <attr> = <val2> OR` ...

More general case of a **table constant**:

```
SELECT Name
FROM Country
WHERE (C_ID, capital)
    IN (('BRD','Bonn'),
        ('D',  'Bonn'),
        ('DDR', 'Berlin(Ost)'))
```

Boolean logic ...

.. is crucial:

```
SELECT Country.Name
FROM Country
WHERE NOT (capital != 'Berlin' OR
capital != 'Wien')
```

Result?

Row predicates with **conjunctive** primitives
`a = <value> AND a = <differentValue>` will **never have a non-zero result.**

Remember

All logical differences are big differences
(Wittgenstein)

Corollar:
All logic mistakes are big miscakes

not so big

3-valued logic

NULL values

- comparison result may be **"**unkown**"** if an argument is NULL
  - "unknown" result tuples in any result set
- **comparison only by** `IS [NOT] NULL`

```
(select Country
from Economy
where gdp >= 0
) intersect
(select Country
from Economy
where gdp IS NULL)

Result set : ∅
```

∧	t	u	f
t	t	u	f
u	u	u	f
f	f	f	f

or, not
?

Arithmetic ,functions in search predicates and more

Extensions of RA - Arithmetic expressions

May occur in simple predicates and target list

Basically arithmetic expressions (over attributes and values) allowed when attribute names allowed.

```
SELECT c.name,
      e.gdp/c.population AS "GDP ($) per Person"
FROM Country c join Economy e
     ON c.code = e.country
WHERE (gdp*1000000/population) < 500
```

Result is NULL if any involved attribute is NULL

Simple SQLString search expressions

String expressions

Simple form of regular expressions: LIKE

LIKE patterns:
% : any sequence of characters
_ : exactly one character

```
SELECT Country.name , capital
FROM Country
WHERE capital LIKE '%co%'

NAME                                      CAPITAL
--------------                            --------
Russia                                     Moscow
...
```

Regular expressions defined in **SQL99***
`<string> SIMILAR TO <pattern>`
REGEXP_Like (<attr>, <pattern>) (Oracle)

Simple SQL Functions in search expressions

Built in functions

- Expressions may contain functions
- Many arithmetical and string built-in functions
- User defined functions on user defined types (see below)

```
SELECT Country.name , capital
FROM Country
WHERE SOUNDEX(capital) = SOUNDEX
('Monakko')
```

```
NAME         CAPITAL
------------ -------
Nicaragua    Managua
Monaco       Monaco
```

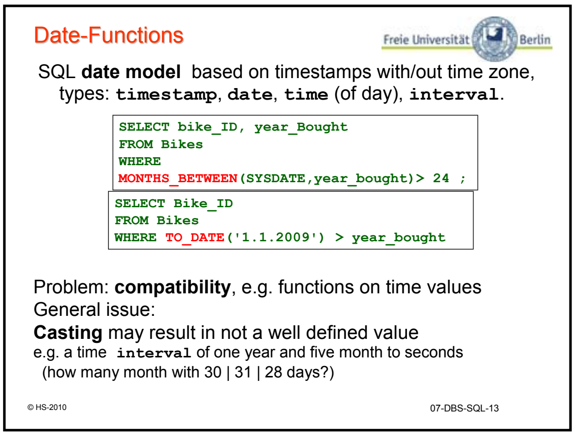
Simple SQL Search expressions

More expressions

Arithmetic expressions	example
Constant	7.5, 3.
[qualifier.]columnname	T.format, fname
arithExpr op arithExp	3 + 4, price - 2*discount
function (aexpr)	Sqrt(xCoord*xCoord + yCoord * yCoord)

Character and Dateexpressions

cexpr '+' cexpr	'The winner is: ' + fname
function (cexpr)	SOUNDEX ('Meier')
	UPPER (fname), LOWER(...)
	TRIM (TRAILING ' ' FROM ' Hello ')
	SUBSTRING(fname FROM 0 FOR 4)
Date value express.	SYSDATE – date_of_birth



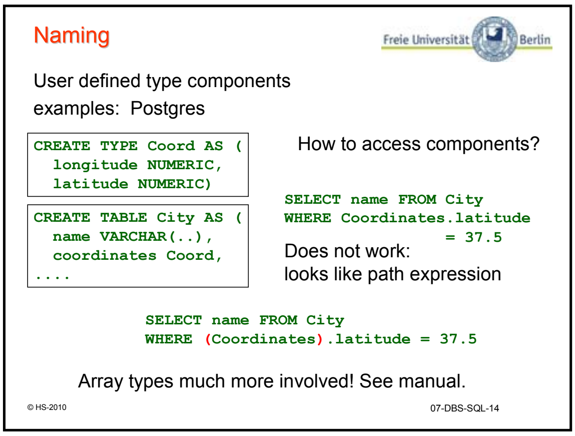
Date-Functions

SQL **date model** based on timestamps with/out time zone, types: `timestamp`, `date`, `time` (of day), `interval`.

```
SELECT bike_ID, year_Bought
FROM Bikes
WHERE
MONTHS_BETWEEN(SYSDATE,year_bought)> 24 ;
```

```
SELECT Bike_ID
FROM Bikes
WHERE TO_DATE('1.1.2009') > year_bought
```

Problem: **compatibility**, e.g. functions on time values
General issue:
Casting may result in not a well defined value
e.g. a time `interval` of one year and five month to seconds
(how many month with 30 | 31 | 28 days?)



Naming

User defined type components

examples: Postgres

```
CREATE TYPE Coord AS (
  longitude NUMERIC,
  latitude NUMERIC)
```

```
CREATE TABLE City AS (
  name VARCHAR(..),
  coordinates Coord,
....
```

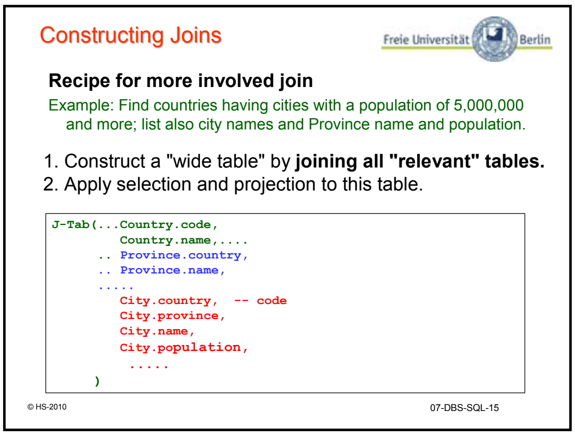
How to access components?

```
SELECT name FROM City
WHERE Coordinates.latitude
                    = 37.5
```

Does not work:
looks like path expression

```
SELECT name FROM City
WHERE (Coordinates).latitude = 37.5
```

Array types much more involved! See manual.



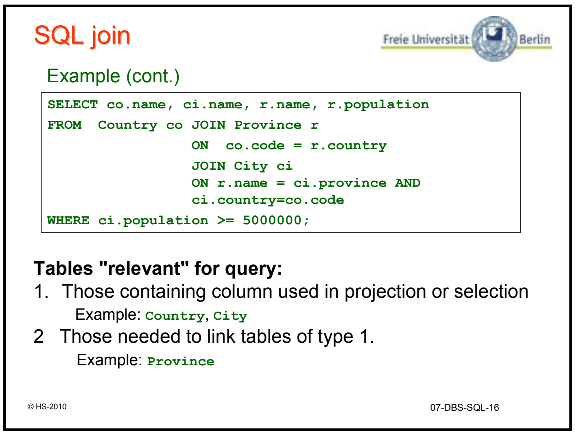
Constructing Joins

Recipe for more involved join

Example: Find countries having cities with a population of 5,000,000 and more; list also city names and Province name and population.

1. Construct a "wide table" by **joining all "relevant" tables.**
2. Apply selection and projection to this table.

```
J-Tab(...Country.code,
         Country.name,....
      .. Province.country,
      .. Province.name,
      .....
         City.country,   -- code
         City.province,
         City.name,
         City.population,
          .....
      )
```



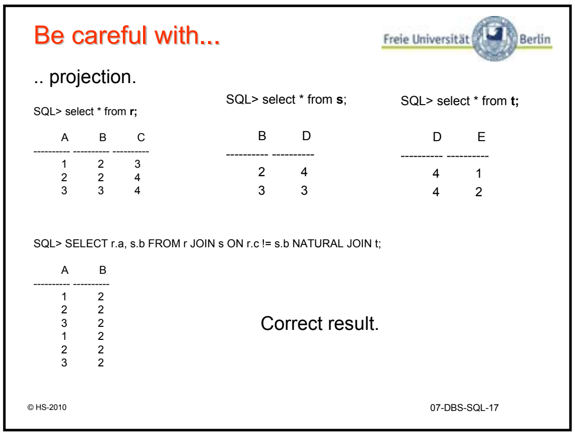
SQL join

Example (cont.)

```
SELECT co.name, ci.name, r.name, r.population
FROM  Country co JOIN Province r
                 ON  co.code = r.country
                 JOIN City ci
                 ON r.name = ci.province AND
                 ci.country=co.code
WHERE ci.population >= 5000000;
```

Tables "relevant" for query:

1. Those containing column used in projection or selection
   Example: `Country`, `City`
2 Those needed to link tables of type 1.
   Example: `Province`



Be careful with...

.. projection.

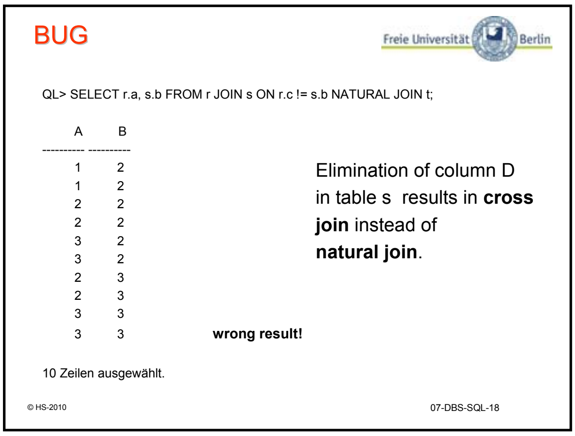
```
SQL> select * from r;

         A          B          C
---------- ---------- ----------
         1          2          3
         2          2          4
         3          3          4
```

```
SQL> select * from s;

         B          D
---------- ----------
         2          4
         3          3
```

```
SQL> select * from t;

         D          E
---------- ----------
         4          1
         4          2
```

```
SQL> SELECT r.a, s.b FROM r JOIN s ON r.c != s.b NATURAL JOIN t;

         A          B
---------- ----------
         1          2
         2          2
         3          2
         1          2
         2          2
         3          2
```

Correct result.



BUG

```
QL> SELECT r.a, s.b FROM r JOIN s ON r.c != s.b NATURAL JOIN t;

         A          B
---------- ----------
         1          2
         1          2
         2          2
         2          2
         3          2
         3          2
         2          3
         2          3
         3          3
         3          3

10 Zeilen ausgewählt.
```

Elimination of column D in table s results in **cross join** instead of **natural join**.

wrong result!

SQL / DML: joins

enhanced SQL:1999

Natural inner join

```
<tableName> NATURAL [INNER] JOIN <tableName>
```

You should know what you are doing...

Example:

```
SELECT name, name
FROM City c NATURAL INNER JOIN Province r;
```

City (NAME, COUNTRY, PROVINCE, POPULATION..)
Province (NAME,COUNTRY, POPULATION,...)

Result?

SQL / DML: Simple queries with joins

Inner equi-join with attribute list

```
<tableName> [INNER] JOIN <tableName>
USING <attributList>
```

Subset of common attributes

Example:

```
SELECT City.name, Province.name
FROM City INNER JOIN Province USING (country)
ORDER BY City.name;
```

Strange (wrong!) result...

Explain output!

Symmetry of joins or tables

Problems with **symmetric relationships**

Example: `Neighbor_of (Country1, Country2)`
Wanted: list of neighbors of Germany.

```
SELECT Country1, Country2
FROM Neighbor_of
WHERE Country1 = 'D' or Country2= 'D'
```

Solves the problem...?

```
COUNTRY1 COUNTRY2
-------- --------
..
CS       D
D        NL
...
```

CASE

```
SELECT 'D ' ,
   (CASE
     WHEN n1.country1='D' THEN n1.country2
     WHEN n1.country2='D' THEN n1.country1
     -- Else for catch all, not needed here
   END) AS "Neighbor-Country"
FROM Neighbor_of n1
WHERE n1.country1='D' OR n1.country2='D'
```

Simple solution in this case: set operator

```
(SELECT country2 as benachbart
 FROM Borders
 WHERE Country1='D')
 UNION
 (SELECT country1 as benachbart
 FROM Borders
 WHERE Country2='D')
```

CASE

Case expression in "target list" very useful.

```
SELECT Country.Name ,
      GNP/population AS "GNP ($) per
                        Person"
...
```

throws exception if `country.population = 0` **(but not:** `NULL`**)**

Can be avoided with CASE .

Outer Join

Natural outer join

```
<tableName> LEFT|RIGHT|FULL
NATURAL [OUTER] JOIN <tableName>
```

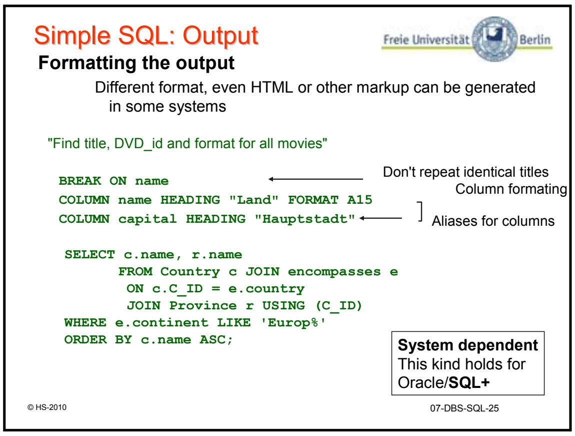
Outer join with condition

```
<tableName> LEFT|RIGHT|FULL [OUTER] JOIN <tableName>
ON <condition>
```

Example:

```
SELECT r.name, c.name
FROM Province r LEFT OUTER JOIN City c
  ON (r.name = c.province AND r.C_ID = c.C_ID)
ORDER BY r.name
```

will find and output also `Provinces` without `cities`



Simple SQL: Output

Formatting the output

Different format, even HTML or other markup can be generated in some systems

"Find title, DVD_id and format for all movies"

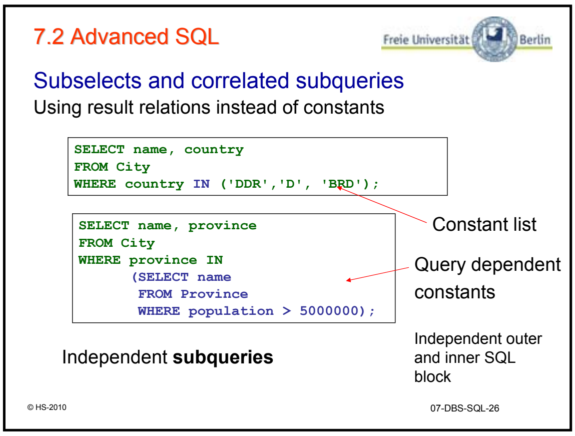
```
BREAK ON name
COLUMN name HEADING "Land" FORMAT A15
COLUMN capital HEADING "Hauptstadt"

 SELECT c.name, r.name
        FROM Country c JOIN encompasses e
         ON c.C_ID = e.country
         JOIN Province r USING (C_ID)
 WHERE e.continent LIKE 'Europ%'
 ORDER BY c.name ASC;
```

Don't repeat identical titles

Column formating

Aliases for columns

System dependent
This kind holds for
Oracle/**SQL+**



7.2 Advanced SQL

Subselects and correlated subqueries

Using result relations instead of constants

```
SELECT name, country
FROM City
WHERE country IN ('DDR','D', 'BRD');
```

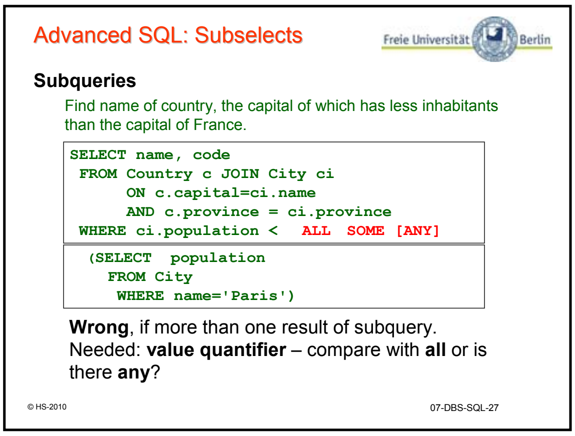
Constant list

```
SELECT name, province
FROM City
WHERE province IN
       (SELECT name
        FROM Province
        WHERE population > 5000000);
```

Query dependent constants

Independent **subqueries**

Independent outer and inner SQL block



Advanced SQL: Subselects

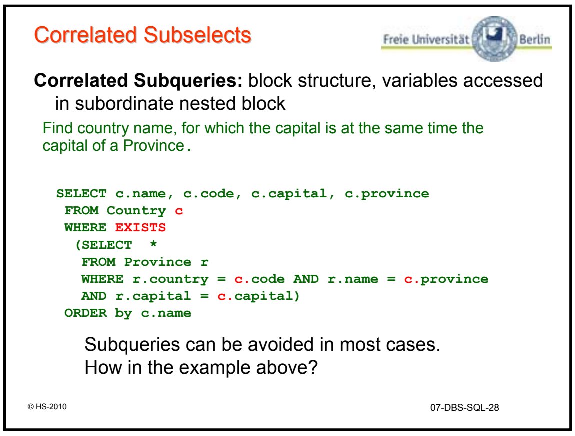
Subqueries

Find name of country, the capital of which has less inhabitants than the capital of France.

```
SELECT name, code
 FROM Country c JOIN City ci
      ON c.capital=ci.name
      AND c.province = ci.province
 WHERE ci.population <   ALL  SOME [ANY]
```

```
  (SELECT  population
    FROM City
      WHERE name='Paris')
```

Wrong, if more than one result of subquery.
Needed: **value quantifier** – compare with **all** or is there **any**?



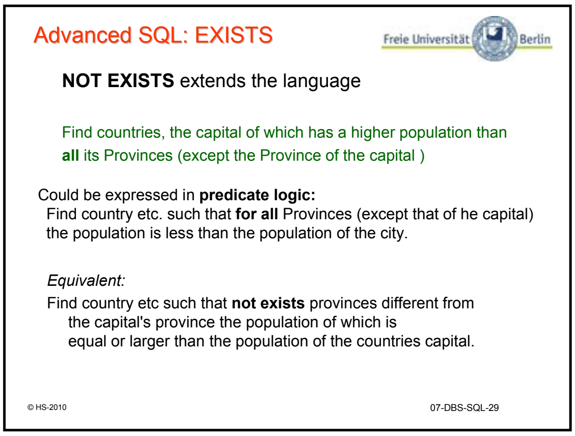
Correlated Subselects

Correlated Subqueries: block structure, variables accessed in subordinate nested block

Find country name, for which the capital is at the same time the capital of a Province.

```
SELECT c.name, c.code, c.capital, c.province
 FROM Country c
 WHERE EXISTS
  (SELECT  *
   FROM Province r
   WHERE r.country = c.code AND r.name = c.province
   AND r.capital = c.capital)
 ORDER by c.name
```

Subqueries can be avoided in most cases.
How in the example above?



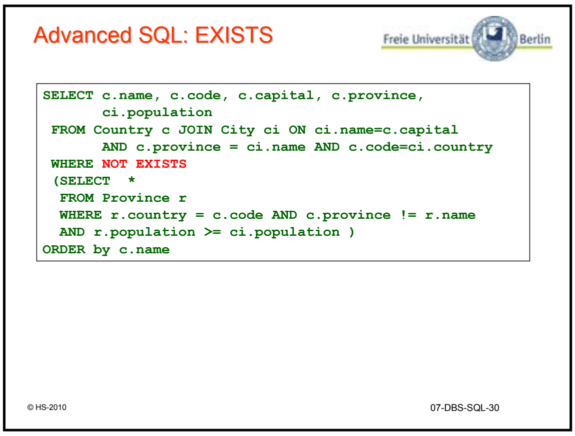
Advanced SQL: EXISTS

NOT EXISTS extends the language

Find countries, the capital of which has a higher population than **all** its Provinces (except the Province of the capital)

Could be expressed in **predicate logic:**
Find country etc. such that **for all** Provinces (except that of he capital) the population is less than the population of the city.

Equivalent:
Find country etc such that **not exists** provinces different from the capital's province the population of which is equal or larger than the population of the countries capital.



Advanced SQL: EXISTS

```
SELECT c.name, c.code, c.capital, c.province,
       ci.population
 FROM Country c JOIN City ci ON ci.name=c.capital
       AND c.province = ci.name AND c.code=ci.country
 WHERE NOT EXISTS
 (SELECT  *
  FROM Province r
  WHERE r.country = c.code AND c.province != r.name
  AND r.population >= ci.population )
ORDER by c.name
```

Division and EXISTS

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Find countries which are members of **all** organizations, Germany is in.

Algebra expression?

```
SELECT DISTINCT country
FROM IsMember m1
WHERE NOT EXISTS (
  SELECT * FROM IsMember m2
  WHERE country = 'D' AND NOT EXISTS (
    SELECT *  FROM IsMember m3
    WHERE m3.country = m1.country AND
          m3.organization = m2.organization
    )
  )
```

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Set operators

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Find countries which belong to Europe and Asia.

... where continent = 'Europe' ~~and~~ continent = 'Asia'

```
SELECT country FROM encompasses
WHERE continent = 'Europe'
INTERSECT
SELECT country FROM encompasses
WHERE continent = 'Asia'
```

Set operators eliminate duplicates!
<set op> ALL does not.

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Quantification and set operators

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Example from above...

```
SELECT country        -- not in Oracle
FROM IsMember m
WHERE NOT EXISTS(
  (SELECT organization FROM IsMember
   WHERE country='D'
   )
   EXCEPT
   (SELECT organization FROM IsMember m1
    WHERE m.country = m1.country
    )
   )
```

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Table expressions

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```
SELECT name FROM  country c
WHERE c.code IN (
   SELECT country FROM encompasses
   WHERE continent = 'Europe'
   INTERSECT
   SELECT country FROM encompasses
   WHERE continent = 'Asia'
   )
```

Avoid subqueries, even if not correlated

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Table expressions

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```
SELECT name FROM  country c,
    ( SELECT country FROM encompasses
     WHERE continent = 'Europe'
     INTERSECT
     SELECT country FROM encompasses
     WHERE continent = 'Asia'
     ) euroAsia
  WHERE euroAsia.country = c.code
```

table expression
in from list

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Aggregation and Grouping

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Aggregate (or set) functions

f_A : table -> value, where A is some Subset of Σ(table)

Aggregate functions are table functions, i.e. defined on tables or subsets of tables, not single rows

COUNT, SUM, AVG, VARIANCE,MIN, MAX are standard functions sometimes also statistical functions (e.g. variance)

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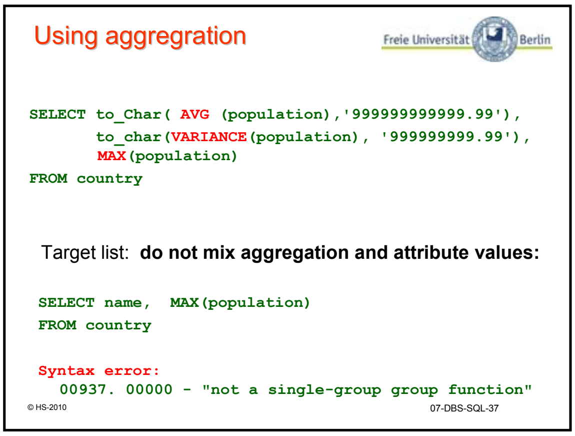


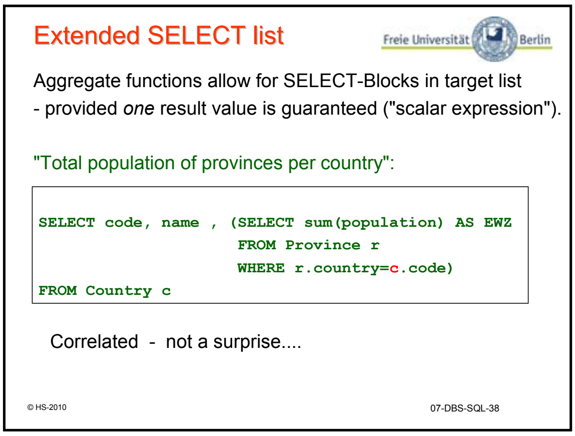
Using aggregration

```
SELECT to_Char( AVG (population),'999999999999.99'),
       to_char(VARIANCE(population), '999999999.99'),
       MAX(population)
FROM country
```

Target list: **do not mix aggregation and attribute values:**

```
SELECT name,  MAX(population)
FROM country
```

```
Syntax error:
  00937. 00000 - "not a single-group group function"
```



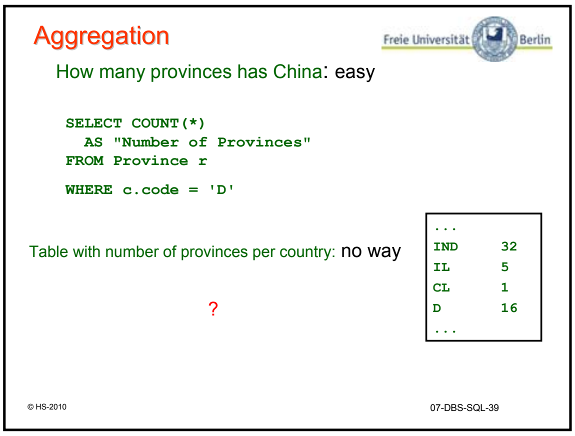
Extended SELECT list

Aggregate functions allow for SELECT-Blocks in target list
- provided *one* result value is guaranteed ("scalar expression").

"Total population of provinces per country":

```
SELECT code, name , (SELECT sum(population) AS EWZ
                     FROM Province r
                     WHERE r.country=c.code)
FROM Country c
```

Correlated - not a surprise....



Aggregation

How many provinces has China: easy

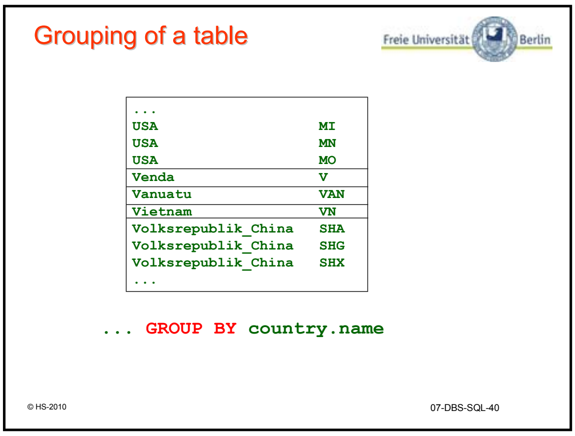
```
SELECT COUNT(*)
  AS "Number of Provinces"
FROM Province r

WHERE c.code = 'D'
```

Table with number of provinces per country: no way

?

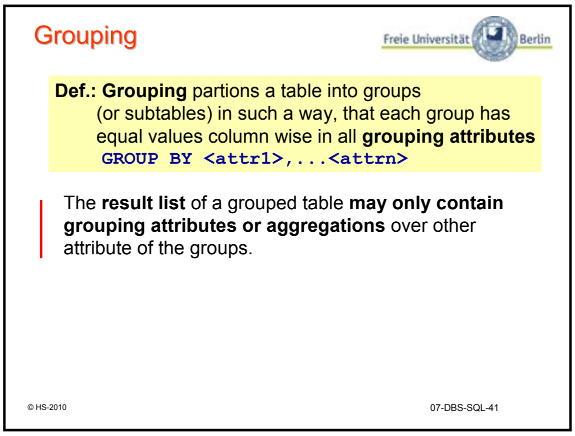
```
...
IND    32
IL     5
CL     1
D      16
...
```



Grouping of a table

```
...
USA                    MI
USA                    MN
USA                    MO
Venda                  V
Vanuatu                VAN
Vietnam                VN
Volksrepublik_China    SHA
Volksrepublik_China    SHG
Volksrepublik_China    SHX
...
```

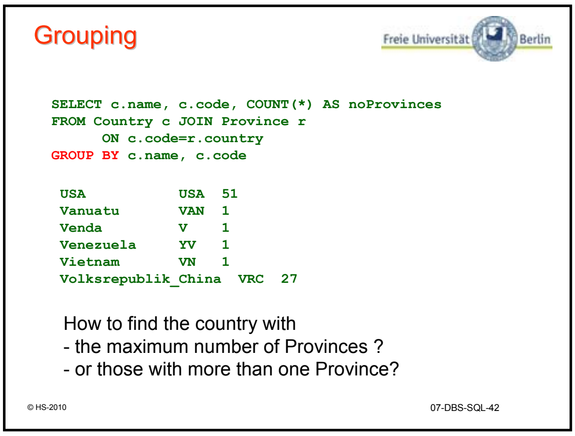
```
... GROUP BY country.name
```



Grouping

Def.: Grouping partions a table into groups (or subtables) in such a way, that each group has equal values column wise in all **grouping attributes**
`GROUP BY <attr1>,...<attrn>`

The **result list** of a grouped table **may only contain grouping attributes or aggregations** over other attribute of the groups.



Grouping

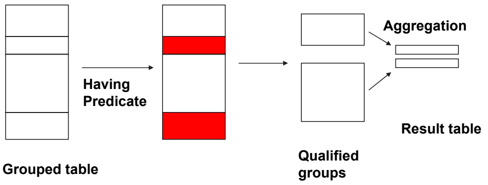
```
SELECT c.name, c.code, COUNT(*) AS noProvinces
FROM Country c JOIN Province r
      ON c.code=r.country
GROUP BY c.name, c.code
```

```
USA              USA  51
Vanuatu          VAN  1
Venda            V    1
Venezuela        YV   1
Vietnam          VN   1
Volksrepublik_China  VRC  27
```

How to find the country with
- the maximum number of Provinces ?
- or those with more than one Province?

Having

Group based selection:



```
SELECT c.name, c.code, COUNT(*) AS noRegs
FROM Country c JOIN Province r ON c.code=r.country
GROUP BY c.name, c.code
HAVING COUNT(*) > 1
```

Having

Predicates in having clause:
defined only on grouped columns or aggregated by a set function

```
SELECT c.name, c.code, SUM (ci.population) AS
"Stadtbevoelkerung"
 FROM Country c JOIN City ci ON c.province =
ci.province AND c.code=ci.country
 GROUP BY c.name, c.code
 HAVING SUM(ci.population) > 0
```

- "No HAVING without 'GROUP BY' "
- Attributes in Target list must be group attributes

Row and table predicates

Row predicates: evaluated for each individual row
Table predicates: evaluated on tables or groups.
" A group / table is qualified or not"

No aggregation in row predicates: MAX, COUNT() etc do not make any sense.

Aggregation mandatory for table predicates:
`COUNT(*) > 2,  MAX(population)`

Brain teaser: can table predicates be expressed by row predicates?

Using group by

For readability, we introduce a **VIEW**:

```
CREATE VIEW NoReg AS (
SELECT c.name, c.code, COUNT(*) AS nofRegs
FROM Country c JOIN Province r ON c.code=r.country
GROUP BY c.name, c.code )
```

Standard step: **construct a joined table with** all the **information needed**. Join previous expression with `NoReg`

```
SELECT c.name, c.code, c.capital, c.province, ci.population
 FROMNCountry c JOIN City ci ON ci.name=c.capital
      AND c.province = ci.province AND c.code=ci.country
     JOIN NoReg n on n.name = c.name AND n.code = c.code
WHERE n.nofRegs > 1    -- now a row predicate!
AND ...- - WHERE EXISTS..
```

Expl. cont.

```
SELECT c.name, c.code, c.captal, c.province, ci.population
 FROM Country c JOIN City ci ON ci.name=c.capital
       AND c.code = ci.province AND c.code=ci.country
      JOIN NoReg n on n.name = c.name AND n.C_ID = c.C_ID
WHERE n.nofRegs > 1    -- now a row predicate!
AND  NOT EXISTS
      (SELECT  *
       FROM Province r
       WHERE r.country = c.code AND c.province != r.province
       AND r.population > ci.population )
     ORDER by c.name
```

```
NAME              C_ID CAPITAL    R_ID POPULATION
----------------- ---- ---------- ---- ------------
Daenemark         DK   Kopenhagen DK   1358540
Grossbritannien   GB   London     ENG  6754500
...
Volksrepublik_China VRC  Peking     PEK  9900000

11 rows selected
```

Advanced SQL

Quantifiers and **counting** (in finite sets)

```
select  x                        select  x
from    R                   ≡    from    R
where  EXISTS                    where  0 <
        (select * from S...)             (select count(* ) from S...)
```

```
SELECT DISTINCT country
FROM IsMember m1
WHERE 0 =(
  SELECT Count(*) FROM IsMember m2
  WHERE country = 'D' AND NOT EXISTS (
    SELECT *  FROM IsMember m3
    WHERE m3.country = m1.country AND
          m3.organization = m2.organization
    )
  )
```

GROUP BY

A realistic example[1]

```
product (product_id, name, price, cost)
sales (product_id, units, date, ...)
```

"Find for each product the profit made within the last 4 weeks if less than 500 $ "

```
SELECT p.product_id, p.name,
       (sum(s.units) * (p.price - p.cost)) AS profit
FROM products p LEFT JOIN sales s USING (product_id)
WHERE s.date > CURRENT_DATE - INTERVAL '4 weeks'
GROUP BY product_id, p.name, p.price, p.cost
HAVING sum(p.price * s.units) < 500;
```

[1] from the Postgres manual

SQL / DML Structuring

SQL -3

Temporary tables

When **inconsistency** is not an issue, temporary tables make sense

No assignment in SQL – applicative language

Instead: **Declare temporary relation** :

```
create temporary table myTmp ( ....)
```

and **assign a value** by means of an **INSERT** statement:

useful variant of insert ⇨

```
insert into mytmp
  (select x,y,z from R where…)
```

Temporary tables are **local snapshots**, they are "dropped" at the end of a session.

Structuring

Consistency thread in multiuser mode!

Structuring

Subquery factoring / local definition

```
WITH r AS (
   select  m.title, m.m_id AS x, tt.m_id
   from movie m, DVD tt
   where m.year > to_date(2000,'YYYY') )

SELECT DISTINT r.title, t.DVD_id
from r, DVD t
where r.x = t.m_id;
```

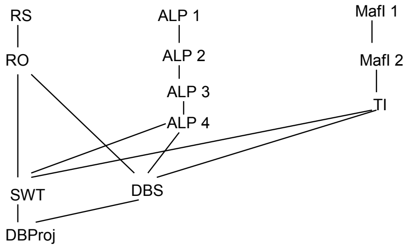
Local definition

Compare **let** in Haskell

Transitive closure

Representing a directed Graph

Example: course prerequisites



Represent graph by a set of nodes and a set of edges

Transitive closure

Example: Find courses required for SWT

enhanced SQL:1999

```
-- Nodes
CREATE TABLE Course(
lnr int  primary key,
name varchar(20));
```

```
-- Edges
CREATE TABLE Requires(
pre int  references course(lnr),
suc int  references course(lnr),
constraint req_pk primary key(pre, suc));
```

ANSI SQL: Transitive closure

ANSI SQL (SQL 99) syntax for recursive traversals

```
WITH RECURSIVE PreCourse( pre, suc  )
   AS (SELECT pre,suc FROM Requires r WHERE pre
        NOT IN (SELECT suc FROM Requires r1)
   UNION
       SELECT pre,suc
       FROM Requires r, PreCourses p
       WHERE p.suc = r.pre
       )
SELECT p1.suc , c.name
FROM preCourse p1, course c
WHERE    p1.suc = c.lnr;
```

Recursive processing

Querying a table recursively

(1) Construct the table which is recursively defined
Example: `PreCourses (pre,suc)` which is the transitive closure of the `Requires` table

(1a) Start with the "base" relation `Requires`
Requires → `PreCourses`^{0}

(1b) construct `Precourses`$^{n+1}$ `:`

`PreCourses`^{n} `union` [all]
additional transitive dependent tuples using `Requires` and `PreCourses`^{n}

(2) Use constructed table (`PreCourses`) for querying

Termination?

The (iterative!) algorithm which constructs the transitive closure, terminates, if there are no new tuples to be added:

`PreCourses`^{n} `= PreCourses`$^{n+1}$

Crucial: The **result set** of the query defining the "delta" must **eventually be empty**!

In the example:

```
SELECT pre,suc
        FROM Requires r, PreCourses p
WHERE p.suc = r.pre
```

Oracle: different mechanism

ORACLE

Transitive Closure in Oracle: CONNECT

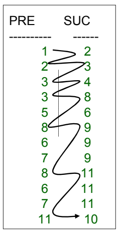
Courses

LNR	NAME
1	ALP I
2	ALP 2
3	ALP 3
4	ALP 4
5	RS
6	RO
7	Theory
8	SWP
9	DBS
10	DBProj
11	SWT

```
SELECT l.name
FROM Course l, requires r
WHERE  r.suc = l.lnr
START WITH pre = 1
CONNECT BY PRIOR suc = pre;
```

```
NAME
-----------
ALP 2
ALP 3
ALP 4
SWP
DBS
SWT
DBProj
```

Requires



PRE	SUC
1	2
2	3
3	4
3	8
5	6
8	9
6	9
7	9
8	11
6	11
7	11
11	10

1. Only ONE path ("start with..")
2. from leaf to root: exchange `suc` and `pre`

SQL / DML: Overview

Query data

- Interactively
- Embedded in host language
  important in applications, next chapter

Insert, update, delete data

7.3 SQL / DML: Update operations

Delete, Insert, Update

The easiest way to ruin your company:

```
DELETE FROM Customer;
```

deletes all rows from `Customer` relation

In general, the rows to be deleted are specified by a (search) predicate:

```
DELETE FROM <tablename> WHERE <predicate>;
```

Very different from **deleting metadata:**

```
DROP TABLE Customers;    DROP SCHEMA my_database;
```

SQL / DML: Update

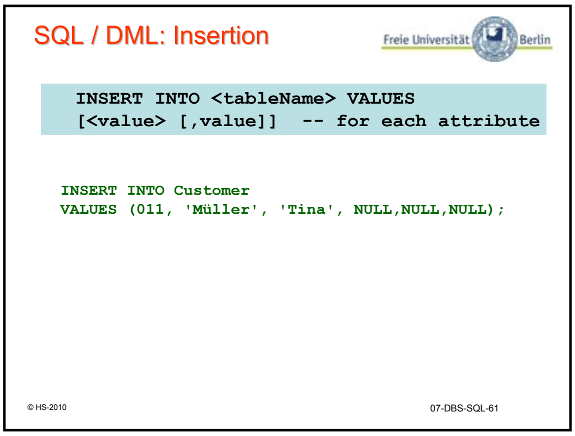
General form (simplified) for changing values :

```
UPDATE <tableName> SET
  <attr> = <value> [, <attr> = <value> ]0..*
    WHERE <searchPredicate>
```

- Note: without a predicate all rows will be changed

- **Primary key predicate for update** is very common

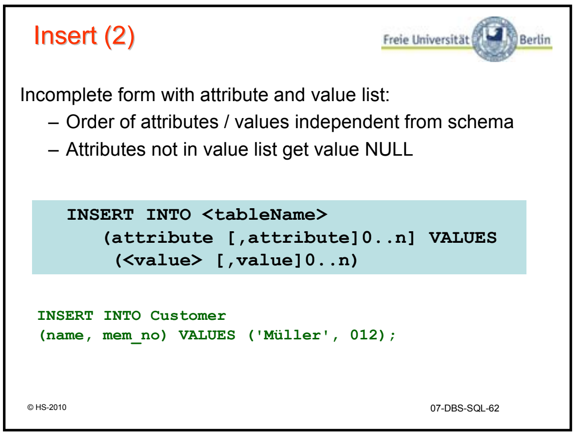
```
Update Customer SET email = 'me@acm.org'
 WHERE mem_No = 47.1;    /* primary key */
Update Rental SET until_date = SYSDATE
WHERE bike_id = 23-7789 AND c_id = 3315
AND until_date IS NULL;
```



SQL / DML: Insertion

```
INSERT INTO <tableName> VALUES
[<value> [,value]]  -- for each attribute
```

```
INSERT INTO Customer
VALUES (011, 'Müller', 'Tina', NULL,NULL,NULL);
```



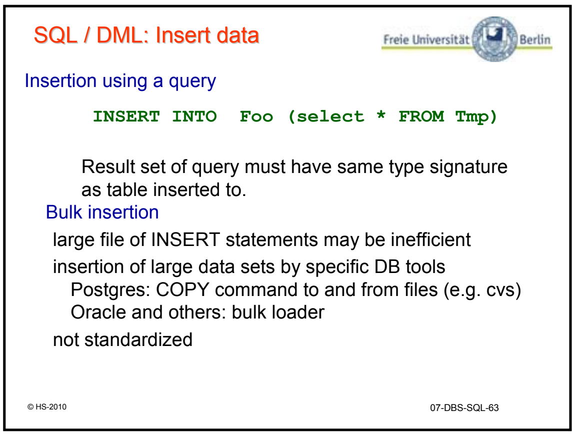
Insert (2)

Incomplete form with attribute and value list:

- Order of attributes / values independent from schema
- Attributes not in value list get value NULL

```
INSERT INTO <tableName>
   (attribute [,attribute]0..n] VALUES
    (<value> [,value]0..n)
```

```
INSERT INTO Customer
(name, mem_no) VALUES ('Müller', 012);
```



SQL / DML: Insert data

Insertion using a query

```
INSERT INTO  Foo (select * FROM Tmp)
```

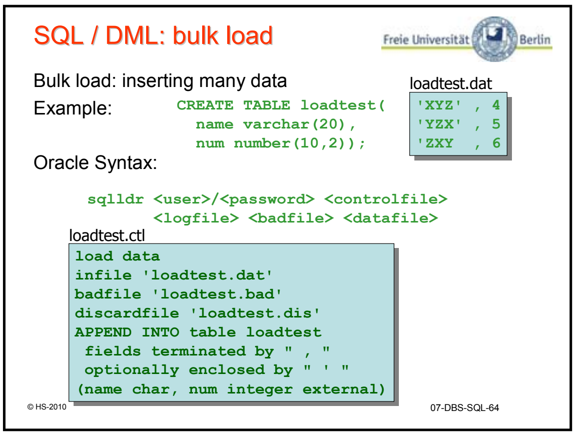
Result set of query must have same type signature as table inserted to.

Bulk insertion

large file of INSERT statements may be inefficient

insertion of large data sets by specific DB tools
Postgres: COPY command to and from files (e.g. cvs)
Oracle and others: bulk loader

not standardized



SQL / DML: bulk load

Bulk load: inserting many data

Example:

```
CREATE TABLE loadtest(
  name varchar(20),
  num number(10,2));
```

loadtest.dat

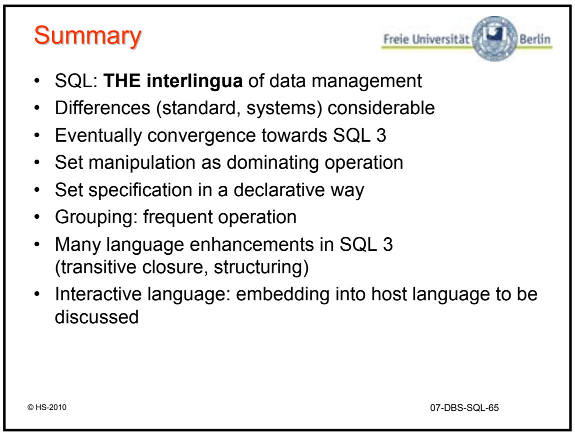
```
'XYZ' , 4
'YZX' , 5
'ZXY  , 6
```

Oracle Syntax:

```
sqlldr <user>/<password> <controlfile>
       <logfile> <badfile> <datafile>
```

loadtest.ctl

```
load data
infile 'loadtest.dat'
badfile 'loadtest.bad'
discardfile 'loadtest.dis'
APPEND INTO table loadtest
 fields terminated by " , "
 optionally enclosed by " ' "
(name char, num integer external)
```



Summary

- SQL: **THE interlingua** of data management
- Differences (standard, systems) considerable
- Eventually convergence towards SQL 3
- Set manipulation as dominating operation
- Set specification in a declarative way
- Grouping: frequent operation
- Many language enhancements in SQL 3 (transitive closure, structuring)
- Interactive language: embedding into host language to be discussed