SQL query

Query elementys:

```
select result_specification
   from tables
   [where select_conditions]
   [group by grouping_criteria]
   [having group_restrictions]
   [order by ordering_criteria]
```

may be missing

SQL-query

- A query produces an anonymous result table.
- The values for the elements in the result_specification are computed for each row combination that satisfies the selection criteria listed after the keyword where.

SQL query

- The from-part of a query may contain one or more tables (or subqueries)
  - If there is only one table the operation is selection
- If there are many tables, the operation is cross product unless there are join conditions in the where-part, in which case the operation is join (remember to include the join conditions)

SQL-query

- All the tables that contain data, which should be included in the result, must be listed in the from-part of the query.
- Tables may be temporarily renamed using an alias (correlation name).
  - from .., table_name [as] alias,…
- Temporary renaming is valid only within the query. It's use is necessary in case the same table is used many times within the same query.

SQL-query

- Example: Find pairs of courses sharing the same lecturer

```
select A.name, B.name
from course A, course B
where A.lecturer=B.lecturer and
        A.courseId<B.courseId
order by A.name, B.name
```

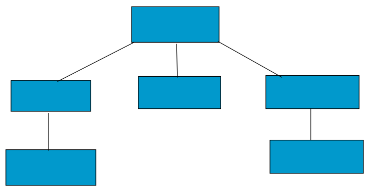
  - Condition A.courseId<B.courseId prevents the same pair of names to be listed twice (in different order) and also pairs where a course is connected to itself.

Building a query

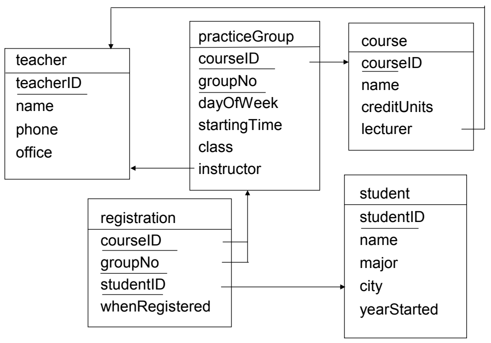
- A typical error in joins is to omit a join condition, in which case the result will contain more rows than it should have
- Typically all the tables of a query should be somehow connected to each other.
- Thus, if there are *n* tables, there should be at least *n-1* join conditions. If joins are based on multiple columns, the number of elementary conditions is bigger than n-1.

Building a query

- Usually queries are composed so that there is one central table that binds the other tables together. It’s possible that no data of this binding table is included in the result.



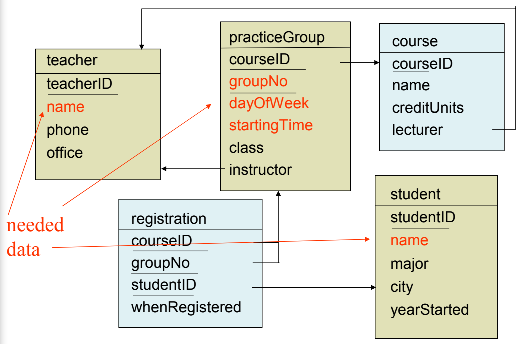
Building a query



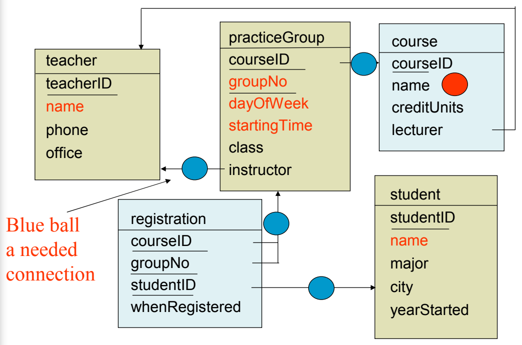
Building a query

- Task: Prepare a report of the practice groups in the Java programming course
- What to include
  - Group number (table practicegroup)
  - Instructor’s name (table teacher)
  - Session day (table practicegroup)
  - Session starting time (table practicegroup)
  - Student’s name (table student)
- To connect students and practice groups table registration is needed. To find out the courseID based on the name of course we need table course.

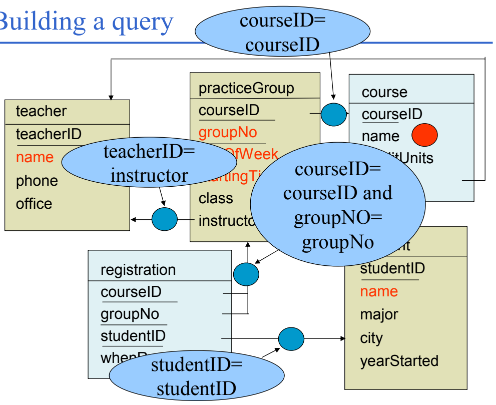
Building a query



Building a query



Building a query



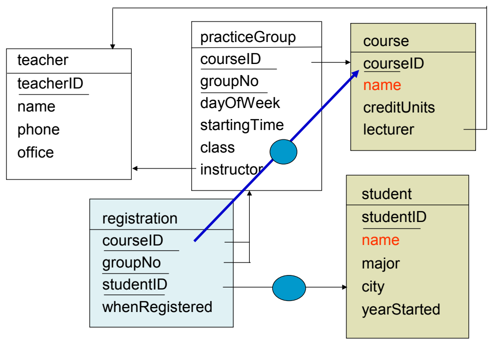
Building a query

```
select P.groupNo, T.name TeacherName, P.dayOfWeek,
P.startingTime, S.name StudentName
from PracticeGroup P, Teacher T, student S, registration
R , course C
where
    P.courseID=C.courseID and
    R.courseID=P.courseID and
    R.groupNo=P.groupNo and
    T.teacherID=P.instructor and
    S.StudentID=R.studentID and
    C.name='Java programming'
order by P.groupNo, S.Name;
```

Building a query

- Although tables are typically connected based on foreign keys, you need not include unnecessary tables in the query
- For example to find out students registered for a certain course you may by-pass the table parcticeGroup

Building a query



Sub-queries

- Sub-queries are queries included inside other queries. They may be used in the where-part of a query and also in the from-part of a query
- A sub-query produces a result table as normal queries
- There are predicates to compare values with the result table (in, not in, Θ some, Θ all, exists, not exists)

Sub-queries

- Find out teachers that give lectures

```
select name from teacher
where teacherID in
    (select lecturer from course)
order by name;
```

- Find out teachers that do not give lectures

```
select name from teacher
where teacherID not in
    (select lecturer from course)
order by name;
```

  – this is one way of expressing difference in SQL

Sub-queries

- Find out teachers that give lectures

```
select name from teacher
where teacherID in
    (select lecturer from course)
order by name;
```

- Find out teachers that do

```
select name from teacher
where teacherID not in
    (select lecturer from course)
order by name;
```

  – this is one way of expressing difference in SQL

the sub-queries here are independent from the external query -May be executed separately only once

Sub-queries (connected)

- Teachers that give lectures

```
select name from teacher
where
exists  (select 'yes' from course
            where lecturer= teacher.teacherID)
order by name;
```

there is a condition that connects the sub-query to the external query

the sub-query must be (logically) executed once for each row of the table in the external query

Sub-queries

- Sub-queries may also be used in the from-part of the query. Their results may be temporarily renamed as well as their columns
- from …, (sub-query) [[as] alias] [(column list)], …
- sub-queries in the from-part are useful when combining aggregate data collected using different criteria

Aggregate queries

- SQL provides a collection of aggregate functions

– AVG	average
– MIN	minimum
– MAX	maximum
– SUM	sum
– COUNT	count

  – When aggregate functions are used in the query there will be only one result row, unless grouping is used.

Aggregate queries

- Find the number of students:
  – select count(*) from student;
  – Counts the number of rows
- A constant may be used as the argument of count to get the same result as above
  – select count(1) from student;
- If a column is given as the argument we get the number of real non-null values in the column
  – select count(studentID) from student;

Aggregate queries

- If keyword distinct precedes the argument, then only distinct non-null values are counted
- Find the number of cities the students live in
- select count(distinct city) from student
- What is the longest time anybody living in Helsinki has studied

```
select 2003-min(startingYear) from student
where city='Helsinki';
```

- When computing average, sum, minimum, and maximum, null values are not
- The average credit units for courses
  – select avg(creditUnit) from course;

Aggregate queries

- It's not possible to include in the answer both detail data and aggregate data from the same set of rows
- Which course gives the biggest amount of credit units and how many?
- This cannot be solved as:

```
select name, max(creditUnits)
from course;
```

detail

aggregate

Aggregate queries

- Which course gives the biggest amount of credit units and how many? Queries that work OK:

```
select name, creditUnits from course
where creditUnits >=
ALL (select creditUnits from course);

Select name, creditUnits from course
where creditUnits=
(select max(creditUnits) from course);

select name,maxUnits
from course,
     (select max(creditUnits) maxUnits from course) as m
where course.creditUnits =m.maxUnits;
```

logically 'different'

Aggregate queries with groups

- If grouping is used the result will contain one row for each group.
- grouping is specified by listing the columns (or expression) the values of which determine the groups
- each distinct value combination determines a group
- groups are formed after the conditions of the where part have been first evaluated

Aggregate queries with groups

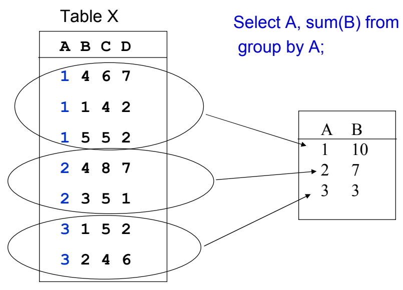


Table X

A	B	C	D
1	4	6	7
1	1	4	2
1	5	5	2
2	4	8	7
2	3	5	1
3	1	5	2
3	2	4	6

```
Select A, sum(B) from X
 group by A;
```

A	B
1	10
2	7
3	3

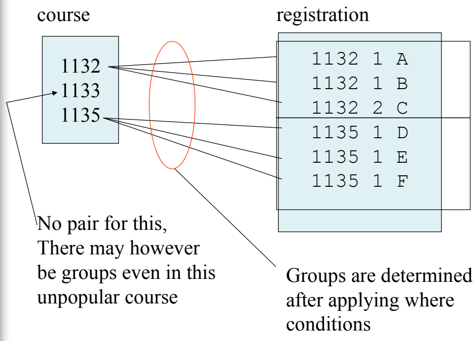
Aggregate queries with groups

- When grouping is used the result may contain only the columns listed in the group by specification, constants and aggregate function results
- All columns listed in the group by specification need not be included in the result (but usually they are)

```
select course.courseID, name, groupNo, count(*)
from course, registration
where registration.courseID=course.courseID
group by course.courseID, name, groupNo;
```

- Name is needed in the above group by specification because we want to include it in the result. It does not affect on how the groups are determined
- The above query does not list all the groups!

Aggregate queries with groups



Aggregate queries with groups

```
select name, groupNo, count(*)
from course, registration
where registration.courseID=course.courseID
group by name, groupNo
```

non-empty

union

empty

```
select name, groupNo, 0
from course, practiceGroup P,
where course.courseID=P.courseID and (course.courseID,
    P.GroupNo) not in
     (select courseID, groupNo from registration)
```

Aggregate queries with groups

- Inclusion of groups in the result may be regulated with having –clause
- Having clause specifies conditions the groups to be included in the result must meet. These conditions typically rely on some aggregate functions
- Find out practice groups with more than 20 students

```
select name, groupID, count(*)
from course, registration
where registration.courseID=course.courseID
group by name, groupNo
having count(*) >20;
```

- (but '<20' would not work for 'less than 20' – because empty groups are not retrieved)

Aggregate queries with groups

- It's possible to construct expressions that contain aggregate functions, but it's not possible to use an aggregate function as an argument of another aggregate function if both are based on the same row population
- Which course has the biggest average group size? Cannot be solved as follows

```
select name, groupNo, max(avg(count(*)))
from course, registration R
where course.courseID=R.courseID
group by name, groupNo
(this gives syntax error)
```

Aggregate queries with groups

Instead:

```
select course.courseID, name, students/groups
  from course,
 (select courseID, count(*) students
    from registration
    group by courseID) as regs,
 (select  courseID, count(*) groups
    from practiceGroup
    group by courseID) as grp
 where course.courseID= regs.courseID and
    course.courseID= grp.courseID and
    students/groups =
```

continues on the next slide

Aggregate queries with groups

```
(select max(students/groups)
  (select courseID, count(*) students
    from registration
    group by courseID) as regs,
  (select  courseID, count(*) groups
    from practiceGroup
    group by courseID) as grp
 where regs.courseID= grp.courseID)
```