



Chapter 3: Introduction to SQL

Database System Concepts, 7th Ed.

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Outline

- Overview of The SQL Query Language
- SQL Data Definition
- Basic Query Structure of SQL Queries
- Additional Basic Operations
- Set Operations
- Null Values
- Aggregate Functions
- Nested Subqueries
- Modification of the Database



History

- IBM Sequel language developed as part of System R project at the IBM San Jose Research Laboratory
- Renamed Structured Query Language (SQL)
- ANSI and ISO standard SQL:
 - SQL-86
 - SQL-89
 - SQL-92
 - SQL:1999 (language name became Y2K compliant!)
 - SQL:2003
- Commercial systems offer most, if not all, SQL-92 features, plus varying feature sets from later standards and special proprietary features.
 - Not all examples here may work on your particular system.



SQL Parts

- DML -- provides the ability to **query information** from the database and to **insert tuples into**, **delete** tuples from, and **modify** tuples in the database.
- integrity – the DDL includes **commands for specifying integrity constraints**.
- View definition -- The DDL includes commands for **defining views**.
- **Transaction control** –includes commands for specifying the beginning and ending of transactions.
- **Embedded SQL** and **dynamic SQL** -- define how SQL statements can be embedded within general-purpose programming languages.
- **Authorization** – includes commands for specifying access rights to relations and views.

/



Data Definition Language

The SQL data-definition language (DDL) allows the specification of information about relations, including:

- The schema for each relation.
- The type of values associated with each attribute.
- The Integrity constraints
- The set of indices to be maintained for each relation.
- Security and authorization information for each relation.
- The physical storage structure of each relation on disk.



Domain Types in SQL

- **char(n)**. Fixed length character string, with user-specified length n .
- **varchar(n)**. Variable length character strings, with user-specified maximum length n .
- **int**. Integer (a finite subset of the integers that is machine-dependent).
- **smallint**. Small integer (a machine-dependent subset of the integer domain type).
- **numeric(p,d)**. Fixed point number, with user-specified precision of p digits, with d digits to the right of decimal point. (ex., **numeric(3,1)**, allows 44.5 to be stored exactly, but not 444.5 or 0.32)
- **real, double precision**. Floating point and double-precision floating point numbers, with machine-dependent precision.
- **float(n)**. Floating point number, with user-specified precision of at least n digits.
- More are covered in Chapter 4.



Create Table Construct

- An SQL relation is defined using the **create table** command:

create table *r*

$(A_1 D_1, A_2 D_2, \dots, A_n D_n,$
 $\text{(integrity-constraint}_1\text{)},$
 $\dots,$
 $\text{(integrity-constraint}_k\text{)})$

- *r* is the name of the relation
- each A_i is an attribute name in the schema of relation *r*
- D_i is the data type of values in the domain of attribute A_i

- Example:

```
create table instructor (  
    ID          char(5),  
    name        varchar(20),  
    dept_name   varchar(20),  
    salary      numeric(8,2))
```



Integrity Constraints in Create Table

- Types of integrity constraints
 - **primary key** (A_1, \dots, A_n)
 - **foreign key** (A_m, \dots, A_n) **references** r
 - **not null**
- SQL prevents any update to the database that violates an integrity constraint.
- Example:

```
create table instructor (
    ID          char(5),
    name        varchar(20) not null,
    dept_name   varchar(20),
    salary      numeric(8,2),
    primary key (ID),
    foreign key (dept_name) references department);
```



And a Few More Relation Definitions

- **create table student (**
ID **varchar(5),**
name **varchar(20) not null,**
dept_name **varchar(20),**
tot_cred **numeric(3,0),**
primary key (ID),
foreign key (dept_name) references department);

- **create table takes (**
ID **varchar(5),**
course_id **varchar(8),**
sec_id **varchar(8),**
semester **varchar(6),**
year **numeric(4,0),**
grade **varchar(2),**
primary key (ID, course_id, sec_id, semester, year) ,
foreign key (ID) references student,
foreign key (course_id, sec_id, semester, year) references section);



And more still

- **create table course (**
 course_id **varchar(8),**
 title **varchar(50),**
 dept_name **varchar(20),**
 credits **numeric(2,0),**
 primary key (course_id),
 foreign key (dept_name) references department);



Updates to tables

- **Insert**
 - `insert into instructor values ('10211', 'Smith', 'Biology', 66000);`
- **Delete**
 - Remove all tuples from the *student* relation
 - `delete from student`
- **Drop Table**
 - `drop table r`
- **Alter**
 - `alter table r add A D`
 - where *A* is the name of the attribute to be added to relation *r* and *D* is the domain of *A*.
 - All exiting tuples in the relation are assigned *null* as the value for the new attribute.
 - `alter table r drop A`
 - where *A* is the name of an attribute of relation *r*
 - Dropping of attributes not supported by many databases.



Basic Query Structure

- A typical SQL query has the form:

```
select A1, A2, ..., An
from r1, r2, ..., rm
where P
```

- A_i represents an attribute
- R_j represents a relation
- P is a predicate.
- The result of an SQL query is a relation.



The select Clause

- The **select** clause lists the attributes desired in the result of a query
 - corresponds to the projection operation of the relational algebra
- Example: find the names of all instructors:

```
select name  
from instructor
```

- NOTE: SQL names are case insensitive (i.e., you may use upper- or lower-case letters.)
 - E.g., $Name \equiv NAME \equiv name$
 - Some people use upper case wherever we use bold font.



The select Clause (Cont.)

- SQL allows duplicates in relations as well as in query results.
- To force the elimination of duplicates, insert the keyword **distinct** after **select**.
- Find the department names of all instructors, and remove duplicates
 - ```
select distinct dept_name
from instructor
```
- The keyword **all** specifies that duplicates should not be removed.

```
select all dept_name
from instructor
```

/



# The select Clause (Cont.)

- An asterisk in the select clause denotes “all attributes”

```
select *
from instructor
```

- An attribute can be a literal with no from clause

```
select '437'
```

- Results is a table with one column and a single row with value “437”
- Can give the column a name using:

```
select '437' as FOO
```

- An attribute can be a literal with from clause

```
select 'A'
from instructor
```

- Result is a table with one column and  $N$  rows (number of tuples in the *instructors* table), each row with value “A”



# The select Clause (Cont.)

- The **select** clause can contain arithmetic expressions involving the operation, +, -, \*, and /, and operating on constants or attributes of tuples.
  - The query:

```
select ID, name, salary/12
from instructor
```

would return a relation that is the same as the *instructor* relation, except that the value of the attribute *salary* is divided by 12.

- Can rename “*salary/12*” using the **as** clause:

```
select ID, name, salary/12 as monthly_salary
```



# The where Clause

- The **where** clause specifies conditions that the result must satisfy
  - Corresponds to the selection predicate of the relational algebra.
- To find all instructors in Comp. Sci. dept

```
select name
from instructor
where dept_name = 'Comp. Sci.'
```

- SQL allows the use of the logical connectives **and, or, and not**
- The operands of the logical connectives can be expressions involving the comparison operators <, <=, >, >=, =, and <>.
- Comparisons can be applied to results of arithmetic expressions
- To find all instructors in Comp. Sci. dept with salary > 80000

```
select name
from instructor
where dept_name = 'Comp. Sci.' and salary > 80000
```



# The from Clause

- The **from** clause lists the relations involved in the query
  - Corresponds to the Cartesian product operation of the relational algebra.
- Find the Cartesian product *instructor X teaches*

```
select *
from instructor, teaches
```

  - generates every possible instructor – teaches pair, with all attributes from both relations.
  - For common attributes (e.g., *ID*), the attributes in the resulting table are renamed using the relation name (e.g., *instructor.ID*)
- Cartesian product not very useful directly, but useful combined with where-clause condition (selection operation in relational algebra).



# Examples

- Find the names of all instructors who have taught some course and the course\_id
  - **select name, course\_id  
from instructor , teaches  
where instructor.ID = teaches.ID**
- Find the names of all instructors in the Art department who have taught some course and the course\_id
  - **select name, course\_id  
from instructor , teaches  
where instructor.ID = teaches.ID and instructor.dept\_name = 'Art'**



# The Rename Operation

- The SQL allows renaming relations and attributes using the **as** clause:

*old-name as new-name*

- Find the names of all instructors who have a higher salary than some instructor in 'Comp. Sci'.

- **select distinct T.name  
from instructor as T, instructor as S  
where T.salary > S.salary and S.dept\_name = 'Comp. Sci.'**

- Keyword **as** is optional and may be omitted

*instructor as T ≡ instructor T*



# Self Join Example

- Relation *emp-super*

| <i>person</i> | <i>supervisor</i> |
|---------------|-------------------|
| Bob           | Alice             |
| Mary          | Susan             |
| Alice         | David             |
| David         | Mary              |

- Find the supervisor of “Bob”
- Find the supervisor of the supervisor of “Bob”
- Can you find ALL the supervisors (direct and indirect) of “Bob”?



# String Operations

- SQL includes a string-matching operator for comparisons on character strings. The operator **like** uses patterns that are described using two special characters:
  - percent ( % ). The % character matches any substring.
  - underscore ( \_ ). The \_ character matches any character.
- Find the names of all instructors whose name **includes the substring “dar”**.

```
select name
from instructor
where name like '%dar%'
```

- Match the string “100%”

```
like '100 \%' escape '\'
```

**in that above we use backslash (\) as the escape character.**



# String Operations (Cont.)

- Patterns are case sensitive.
- Pattern matching examples:
  - 'Intro%' matches any string beginning with “Intro”.
  - '%Comp%' matches any string containing “Comp” as a substring.
  - '\_\_\_' matches any string of exactly three characters.
  - '\_\_\_ %' matches any string of at least three characters.
- SQL supports a variety of string operations such as
  - concatenation (using “||”)
  - converting from upper to lower case (and vice versa)
  - finding string length, extracting substrings, etc.



# Ordering the Display of Tuples

- List in alphabetic order the names of all instructors

```
select distinct name
from instructor
order by name
```

- We may specify **desc** for descending order or **asc** for ascending order, for each attribute; ascending order is the default.
  - Example: **order by name desc**
- Can sort on multiple attributes
  - Example: **order by dept\_name, name**



# Where Clause Predicates

- SQL includes a **between** comparison operator
- Example: Find the names of all instructors with salary between \$90,000 and \$100,000 (that is,  $\geq \$90,000$  and  $\leq \$100,000$ )
  - ```
select name
      from instructor
     where salary between 90000 and 100000
```
- Tuple comparison
 - ```
select name, course_id
 from instructor, teaches
 where (instructor.ID, dept_name) = (teaches.ID, 'Biology');
```



# Set Operations

- Find courses that ran in Fall 2017 or in Spring 2018

```
(select course_id from section where sem = 'Fall' and year = 2017)
union
(select course_id from section where sem = 'Spring' and year = 2018)
```

- Find courses that ran in Fall 2017 and in Spring 2018

```
(select course_id from section where sem = 'Fall' and year = 2017)
intersect
(select course_id from section where sem = 'Spring' and year = 2018)
```

- Find courses that ran in Fall 2017 but not in Spring 2018

```
(select course_id from section where sem = 'Fall' and year = 2017)
except
(select course_id from section where sem = 'Spring' and year = 2018)
```



# Set Operations (Cont.)

- Set operations **union**, **intersect**, and **except**
  - Each of the above operations automatically eliminates duplicates
- To retain all duplicates use the
  - **union all**,
  - **intersect all**
  - **except all**.



# Null Values

- It is possible for tuples to have a null value, denoted by **null**, for some of their attributes
- **null** signifies an unknown value or that a value does not exist.
- The result of any arithmetic expression involving **null** is **null**
  - Example: **5 + null** returns **null**
- The predicate **is null** can be used to check for null values.
  - Example: Find all instructors whose salary is null.  
**select name  
from instructor  
where salary is null**
- The predicate **is not null** succeeds if the value on which it is applied is not null.



# Null Values (Cont.)

- SQL treats as **unknown** the result of any comparison involving a null value (other than predicates **is null** and **is not null**).
  - Example:  $5 < \text{null}$  or  $\text{null} < > \text{null}$  or  $\text{null} = \text{null}$
- The predicate **in a where clause** can involve Boolean operations (**and**, **or**, **not**); thus the definitions of the Boolean operations need to be extended to deal with the value **unknown**.
  - **and** :  $(\text{true and unknown}) = \text{unknown}$ ,  
 $(\text{false and unknown}) = \text{false}$ ,  
 $(\text{unknown and unknown}) = \text{unknown}$
  - **or**:  $(\text{unknown or true}) = \text{true}$ ,  
 $(\text{unknown or false}) = \text{unknown}$   
 $(\text{unknown or unknown}) = \text{unknown}$
- Result of **where clause predicate** is treated as *false* if it evaluates to **unknown**



# Aggregate Functions

- These functions operate on the multiset of values of a column of a relation, and return a value

**avg**: average value

**min**: minimum value

**max**: maximum value

**sum**: sum of values

**count**: number of values



# Aggregate Functions Examples

- Find the average salary of instructors in the Computer Science department
  - `select avg (salary)  
from instructor  
where dept_name= 'Comp. Sci.';`
- Find the total number of instructors who teach a course in the Spring 2018 semester
  - `select count (distinct ID)  
from teaches  
where semester = 'Spring' and year = 2018;`
- Find the number of tuples in the *course* relation
  - `select count (*)  
from course;`



# Aggregate Functions – Group By

- Find the average salary of instructors in each department
  - `select dept_name, avg (salary) as avg_salary  
from instructor  
group by dept_name;`

| <i>ID</i> | <i>name</i> | <i>dept_name</i> | <i>salary</i> |
|-----------|-------------|------------------|---------------|
| 76766     | Crick       | Biology          | 72000         |
| 45565     | Katz        | Comp. Sci.       | 75000         |
| 10101     | Srinivasan  | Comp. Sci.       | 65000         |
| 83821     | Brandt      | Comp. Sci.       | 92000         |
| 98345     | Kim         | Elec. Eng.       | 80000         |
| 12121     | Wu          | Finance          | 90000         |
| 76543     | Singh       | Finance          | 80000         |
| 32343     | El Said     | History          | 60000         |
| 58583     | Califieri   | History          | 62000         |
| 15151     | Mozart      | Music            | 40000         |
| 33456     | Gold        | Physics          | 87000         |
| 22222     | Einstein    | Physics          | 95000         |

| <i>dept_name</i> | <i>avg_salary</i> |
|------------------|-------------------|
| Biology          | 72000             |
| Comp. Sci.       | 77333             |
| Elec. Eng.       | 80000             |
| Finance          | 85000             |
| History          | 61000             |
| Music            | 40000             |
| Physics          | 91000             |



# Aggregation (Cont.)

- Attributes in **select** clause outside of aggregate functions must appear in **group by** list

- /\* erroneous query \*/  
**select dept\_name, ID, avg (salary)**  
**from instructor**  
**group by dept\_name;**



id should also be there

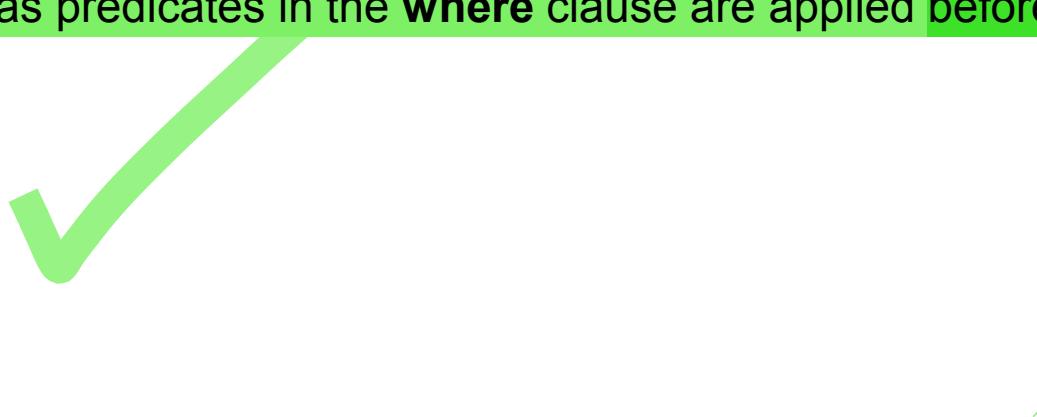


# Aggregate Functions – Having Clause

- Find the names and average salaries of all departments whose average salary is greater than 42000

```
select dept_name, avg (salary) as avg_salary
from instructor
group by dept_name
having avg (salary) > 42000;
```

- Note: predicates in the **having** clause are applied after the formation of groups whereas predicates in the **where** clause are applied before forming groups





# Nested Subqueries

- SQL provides a mechanism for the nesting of subqueries. A **subquery** is a **select-from-where** expression that is nested within another query.
- The nesting can be done in the following SQL query

```
select A1, A2, ..., An
from r1, r2, ..., rm
where P
```



as follows:

- **From clause:**  $r_i$  can be replaced by any valid subquery
- **Where clause:**  $P$  can be replaced with an expression of the form:  
 $B <\text{operation}> (\text{subquery})$

$B$  is an attribute and  $<\text{operation}>$  to be defined later.

- **Select clause:**  
 $A_i$  can be replaced be a subquery that generates a single value.



# Set Membership



# Set Membership

- Find courses offered in Fall 2017 and in Spring 2018

```
select distinct course_id
from section
where semester = 'Fall' and year= 2017 and
course_id in (select course_id
from section
where semester = 'Spring' and year= 2018);
```

- Find courses offered in Fall 2017 but not in Spring 2018

```
select distinct course_id
from section
where semester = 'Fall' and year= 2017 and
course_id not in (select course_id
from section
where semester = 'Spring' and year= 2018);
```



# Set Membership (Cont.)

- Name all instructors whose name is neither “Mozart” nor Einstein”



```
select distinct name
from instructor
where name not in ('Mozart', 'Einstein')
```

- Find the total number of (distinct) students who have taken course sections taught by the instructor with *ID* 10101

```
select count (distinct ID)
from takes
where (course_id, sec_id, semester, year) in
(select course_id, sec_id, semester, year
from teaches
where teaches.ID= 10101);
```

- Note: Above query can be written in a much simpler manner.  
The formulation above is simply to illustrate SQL features



# Set Comparison



# Set Comparison – “some” Clause

- Find names of instructors with salary greater than that of some (at least one) instructor in the Biology department.

```
select distinct T.name
from instructor as T, instructor as S
where T.salary > S.salary and S.dept name = 'Biology';
```

- Same query using > **some** clause

```
select name
from instructor
where salary > some (select salary
from instructor
where dept name = 'Biology');
```



# Definition of “some” Clause

- $F \text{ <comp> some } r \Leftrightarrow \exists t \in r \text{ such that } (F \text{ <comp> } t)$   
Where <comp> can be: <, ≤, >, =, ≠

(5 < some 

|   |
|---|
| 0 |
| 5 |
| 6 |

) = true      (read: 5 < some tuple in the relation)

(5 < some 

|   |
|---|
| 0 |
| 5 |

) = false

(5 = some 

|   |
|---|
| 0 |
| 5 |

) = true

(5 ≠ some 

|   |
|---|
| 0 |
| 5 |

) = true (since 0 ≠ 5)

(= some) ≡ in

However, (≠ some) ≠ not in



# Set Comparison – “all” Clause

- Find the names of all instructors whose salary is greater than the salary of all instructors in the Biology department.

```
select name
from instructor
where salary > all (select salary
 from instructor
 where dept name = 'Biology');
```



# Definition of “all” Clause

- $F \text{ <comp> all } r \Leftrightarrow \forall t \in r \ (F \text{ <comp> } t)$

$(5 < \text{all} \begin{array}{|c|} \hline 0 \\ \hline 5 \\ \hline 6 \\ \hline \end{array}) = \text{false}$

$(5 < \text{all} \begin{array}{|c|} \hline 6 \\ \hline 10 \\ \hline \end{array}) = \text{true}$

$(5 = \text{all} \begin{array}{|c|} \hline 4 \\ \hline 5 \\ \hline \end{array}) = \text{false}$

$(5 \neq \text{all} \begin{array}{|c|} \hline 4 \\ \hline 6 \\ \hline \end{array}) = \text{true} \ (\text{since } 5 \neq 4 \text{ and } 5 \neq 6)$

$(\neq \text{all}) \equiv \text{not in}$

However,  $(= \text{all}) \neq \text{in}$



# Test for Empty Relations

- The **exists** construct returns the value **true** if the argument subquery is nonempty.
- **exists**  $r \Leftrightarrow r \neq \emptyset$
- **not exists**  $r \Leftrightarrow r = \emptyset$

✓



# Use of “exists” Clause

- Yet another way of specifying the query “Find all courses taught in both the Fall 2017 semester and in the Spring 2018 semester”

```
select course_id
from section as S
where semester = 'Fall' and year = 2017 and
exists (select *
 from section as T
 where semester = 'Spring' and year= 2018
 and S.course_id = T.course_id);
```



- Correlation name** – variable S in the outer query
- Correlated subquery** – the inner query



# Use of “not exists” Clause

- Find all students who have taken all courses offered in the Biology department.

```
select distinct S.ID, S.name
from student as S
where not exists ((select course_id
 from course
 where dept_name = 'Biology')
 except
 (select T.course_id
 from takes as T
 where S.ID = T.ID));
```

- First nested query lists all courses offered in Biology
- Second nested query lists all courses a particular student took
- Note that  $X - Y = \emptyset \Leftrightarrow X \subseteq Y$
- Note: Cannot write this query using = all and its variants



# Test for Absence of Duplicate Tuples

- The **unique** construct tests whether a subquery has any duplicate tuples in its result.
- The **unique** construct evaluates to “true” if a given subquery contains no duplicates .
- Find all courses that were offered at most once in 2017

```
select T.course_id
from course as T
where unique (select R.course_id
 from section as R
 where T.course_id= R.course_id
 and R.year = 2017);
```



# Subqueries in the From Clause



# Subqueries in the Form Clause

- SQL allows a subquery expression to be used in the **from** clause
- Find the average instructors' salaries of those departments where the average salary is greater than \$42,000.”

```
select dept_name, avg_salary
from (select dept_name, avg (salary) as avg_salary
 from instructor
 group by dept_name)
 where avg_salary > 42000;
```

- Note that we do not need to use the **having** clause
- Another way to write above query

```
select dept_name, avg_salary
from (select dept_name, avg (salary)
 from instructor
 group by dept_name)
 as dept_avg (dept_name, avg_salary)
 where avg_salary > 42000;
```



# With Clause

- The **with** clause provides a way of defining a temporary relation whose definition is available only to the query in which the **with** clause occurs.
- Find all departments with the maximum budget

```
with max_budget (value) as
 (select max(budget)
 from department)
 select department.name
 from department, max_budget
 where department.budget = max_budget.value;
```



# Complex Queries using With Clause

- Find all departments where the total salary is greater than the average of the total salary at all departments

```
with dept_total(dept_name, value) as
 (select dept_name, sum(salary)
 from instructor
 group by dept_name),
dept_total_avg(value) as
 (select avg(value)
 from dept_total)
select dept_name
from dept_total, dept_total_avg
where dept_total.value > dept_total_avg.value;
```



# Scalar Subquery

- Scalar subquery is one which is used where a single value is expected
- List all departments along with the number of instructors in each department

```
select dept_name,
 (select count(*)
 from instructor
 where department.dept_name = instructor.dept_name)
 as num_instructors
from department;
```

- Runtime error if subquery returns more than one result tuple



# Modification of the Database

- Deletion of tuples from a given relation.
- Insertion of new tuples into a given relation
- Updating of values in some tuples in a given relation



# Deletion

- Delete all instructors

**delete from** *instructor*

- Delete all instructors from the Finance department

**delete from** *instructor*

**where** *dept\_name*= 'Finance';

- *Delete all tuples in the instructor relation for those instructors associated with a department located in the Watson building.*

**delete from** *instructor*

**where** *dept name* in (**select** *dept name*

**from** *department*

**where** *building* = 'Watson');



# Deletion (Cont.)

- Delete all instructors whose salary is less than the average salary of instructors

```
delete from instructor
where salary < (select avg (salary)
 from instructor);
```

- Problem: as we delete tuples from *instructor*, the average salary changes
- Solution used in SQL:
  - First, compute **avg** (salary) and find all tuples to delete
  - Next, delete all tuples found above (without recomputing **avg** or retesting the tuples)



# Insertion

- Add a new tuple to *course*

```
insert into course
```

```
values ('CS-437', 'Database Systems', 'Comp. Sci.', 4);
```

- or equivalently

```
insert into course (course_id, title, dept_name, credits)
```

```
values ('CS-437', 'Database Systems', 'Comp. Sci.', 4);
```

- Add a new tuple to *student* with *tot\_creds* set to null

```
insert into student
```

```
values ('3003', 'Green', 'Finance', null);
```



# Insertion (Cont.)

- Make each student in the Music department who has earned more than 144 credit hours an instructor in the Music department with a salary of \$18,000.

**insert into *instructor***

```
select ID, name, dept_name, 18000
from student
where dept_name = 'Music' and total_cred > 144;
```

- The **select from where** statement is evaluated fully before any of its results are inserted into the relation.

Otherwise queries like

```
insert into table1 select * from table1
```

would cause problem



# Updates

- Give a 5% salary raise to all instructors  
**update *instructor***  
**set salary = salary \* 1.05**
- Give a 5% salary raise to those instructors who earn less than 70000  
**update *instructor***  
**set salary = salary \* 1.05**  
**where salary < 70000;**
- Give a 5% salary raise to instructors whose salary is less than average  
**update *instructor***  
**set salary = salary \* 1.05**  
**where salary < (select avg (salary)**  
**from *instructor*);**



# Updates (Cont.)

- Increase salaries of instructors whose salary is over \$100,000 by 3%, and all others by a 5%
  - Write two **update** statements:

```
update instructor
 set salary = salary * 1.03
 where salary > 100000;
update instructor
 set salary = salary * 1.05
 where salary <= 100000;
```

- The order is important
- Can be done better using the **case** statement (next slide)



# Case Statement for Conditional Updates

- Same query as before but with case statement

```
update instructor
 set salary = case
 when salary <= 100000 then salary * 1.05
 else salary * 1.03
 end
```



# Updates with Scalar Subqueries

- Recompute and update tot\_creds value for all students

```
update student S
set tot_cred = (select sum(credits)
 from takes, course
 where takes.course_id = course.course_id and
 S.ID= takes.ID.and
 takes.grade <> 'F' and
 takes.grade is not null);
```

- Sets *tot\_creds* to null for students who have not taken any course
- Instead of **sum(credits)**, use:

```
case
 when sum(credits) is not null then sum(credits)
 else 0
end
```



# End of Chapter 3