# 数据库系统实验 1 实验报告

数据科学与计算机学院 计算机科学与技术 2016 级
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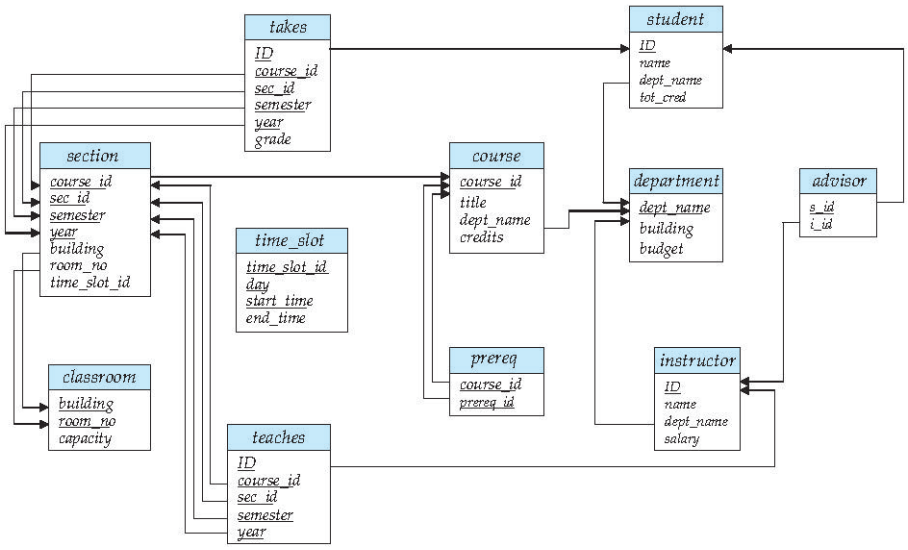
## 1 实验 1.1 数据库定义实验

本实验建立大学数据库模式。大学数据库模式由教室（classroom）、院系（department）、课程科目（course）、导师（instructor）、课程（section）、任教（teaches）、学生（student）、选课（takes）、推荐（advisor）、时间段（time_slot）、课程约束（prereq）共 11 个表组成。




我采用 Mysql 8.0 来做本次实验。

### 1.1 定义数据库

创建一个名为 lab 的数据库。

```
1 create database lab;
```

这样创建出来的数据库模式是默认的，大小写不敏感。

### 1.2 定义基本表

在 lab 数据库中创建 11 个表。

```
create table classroom
    (building       varchar(15),
     room_number        varchar(7),
     capacity       numeric(4,0),
     primary key (building, room_number)
    );
create table department
    (dept_name      varchar(20),
     building       varchar(15),
     budget             numeric(12,2) check (budget > 0),
     primary key (dept_name)
    );
create table course
    (course_id      varchar(8),
     title          varchar(50),
     dept_name      varchar(20),
     credits        numeric(2,0) check (credits > 0),
     primary key (course_id),
     foreign key (dept_name) references department(dept_name)
        on delete set null
    );
create table instructor
    (ID         varchar(5),
     name           varchar(20) not null,
     dept_name      varchar(20),
     salary         numeric(8,2) check (salary > 29000),
     primary key (ID),
     foreign key (dept_name) references department(dept_name)
        on delete set null
    );
create table section
    (course_id      varchar(8),
         sec_id         varchar(8),
     semester       varchar(6)
        check (semester in ('Fall', 'Winter', 'Spring', 'Summer')),
     year           numeric(4,0) check (year > 1701 and year < 2100),
     building       varchar(15),
     room_number        varchar(7),
     time_slot_id       varchar(4),
     primary key (course_id, sec_id, semester, year),
     foreign key (course_id) references course(course_id)
        on delete cascade,
     foreign key (building, room_number) references classroom(building, room_number)
        on delete set null
    );
create table teaches
    (ID         varchar(5),
     course_id      varchar(8),
     sec_id         varchar(8),
```

```
     semester       varchar(6),
     year           numeric(4,0),
     primary key (ID, course_id, sec_id, semester, year),
     foreign key (course_id,sec_id, semester, year) references section(course_id,
         sec_id, semester, year)
        on delete cascade,
     foreign key (ID) references instructor(ID)
        on delete cascade
    );
create table student
    (ID         varchar(5),
     name           varchar(20) not null,
     dept_name      varchar(20),
     tot_cred       numeric(3,0) check (tot_cred >= 0),
     primary key (ID),
     foreign key (dept_name) references department(dept_name)
        on delete set null
    );
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 (course_id,sec_id, semester, year) references section(course_id,
         sec_id, semester, year)
        on delete cascade,
     foreign key (ID) references student(ID)
        on delete cascade
    );
create table advisor
    (s_ID           varchar(5),
     i_ID           varchar(5),
     primary key (s_ID),
     foreign key (i_ID) references instructor (ID)
        on delete set null,
     foreign key (s_ID) references student (ID)
        on delete cascade
    );
create table time_slot
    (time_slot_id       varchar(4),
     day            varchar(1),
     start_hr       numeric(2) check (start_hr >= 0 and start_hr < 24),
     start_min      numeric(2) check (start_min >= 0 and start_min < 60),
     end_hr         numeric(2) check (end_hr >= 0 and end_hr < 24),
     end_min        numeric(2) check (end_min >= 0 and end_min < 60),
     primary key (time_slot_id, day, start_hr, start_min)
    );
```

```
create table prereq
    (course_id      varchar(8),
     prereq_id      varchar(8),
     primary key (course_id, prereq_id),
     foreign key (course_id) references course(course_id)
        on delete cascade,
     foreign key (prereq_id) references course(course_id)
    )
```

### 1.3 实验数据准备

实验使用的 DDL 和数据均从 http://www.db-book.com 下载。

### 1.4 思考题

(1) SQL 语法规定，双引号括定的符号串为对象名称，单引号括定的符号串为常量字符串，那么什么情况下需要用双引号来界定对象名呢?

在 Mysql 中，当对象名称恰为 SQL 保留字时，需用反引号括定，避免歧义。

(2) 数据库对象的完整引用是“服务器名. 数据库名. 模式名. 对象名”，但通常可以省略服务器名和数据库名，甚至模式名，直接用对象名访问对象即可。

使用 mysql 进行数据库连接时，已经提供了服务器名，故可以默认省略服务器名。

建立连接后，使用 use *database*; 选定默认数据库。

省略模式名通常在 from 后面只有一个表，或者有多个表但对象名在这多个表中只出现一次。

### 1.5 实验总结

通过实验，我能读懂表头信息，相当于 excel 表的第一行。每一列指定一个数据类型用于存放数据，这类似于 C++ 。primary key 是主键，它默认是索引，可提高查询效率；foreign key 是外键，用于连接到别的表。

## 2 实验 1.2 数据基本查询实验

### 2.1 单表查询（实现投影操作）

查询学生 ID 、姓名。

```
select ID, name from student limit 10;
```

结果为:

```
+-------+-----------+
| ID    | name      |
+-------+-----------+
| 1000  | Manber    |
| 10033 | Zelty     |
| 10076 | Duan      |
| 1018  | Colin     |
| 10204 | Mediratta |
```

```
| 10267 | Rzecz     |
| 10269 | Hilberg   |
| 10454 | Ugarte    |
| 10481 | Grosch    |
| 10527 | Kieras    |
+-------+-----------+
10 rows in set (0.01 sec)
```

## 2.2 单表查询（实现选择操作）

查询 2009 年春季学期开设的课程 ID 。

```
select course_id from section where semester = 'Spring' and year = '2009';
```

```
+-----------+
| course_id |
+-----------+
| 604       |
| 972       |
+-----------+
2 rows in set (0.01 sec)
```

## 2.3 不带分组过滤条件的分组统计查询

统计每个学生选的课程数。

```
select S.ID, S.name, count(T.course_id)
from student as S, takes as T
where S.ID = T.ID
group by S.ID limit 10;
```

```
+-------+-----------+--------------------+
| ID    | name      | count(T.course_id) |
+-------+-----------+--------------------+
| 1000  | Manber    |                 13 |
| 10033 | Zelty     |                 22 |
| 10076 | Duan      |                 14 |
| 1018  | Colin     |                 22 |
| 10204 | Mediratta |                 12 |
| 10267 | Rzecz     |                 11 |
| 10269 | Hilberg   |                 10 |
| 10454 | Ugarte    |                 18 |
| 10481 | Grosch    |                 17 |
| 10527 | Kieras    |                 21 |
+-------+-----------+--------------------+
10 rows in set (0.01 sec)
```

### 2.4 带分组过滤条件的分组统计查询

查询选课数超过 25 的学生 ID 和姓名。

```
select S.ID, max(S.name)
from student as S, takes as T
where S.ID = T.ID group by S.ID
having count(T.course_id) > 25;
```

```
+-------+-------------+
| ID    | max(S.name) |
+-------+-------------+
| 12078 | Knutson     |
| 44551 | Nguyen      |
| 72669 | Schmitz     |
| 79170 | Lingamp     |
| 90448 | Godfrey     |
+-------+-------------+
5 rows in set (0.05 sec)
```

### 2.5 单表自身连接查询

查询比其中一个计算机系学生获得的学分高的所有学生 ID 和姓名。

```
select distinct S.ID, S.name
from student as S, student as T
where T.dept_name = 'Comp. Sci.' and S.tot_cred > T.tot_cred limit 10;
```

```
+-------+-----------+
| ID    | name      |
+-------+-----------+
| 1000  | Manber    |
| 10033 | Zelty     |
| 10076 | Duan      |
| 1018  | Colin     |
| 10204 | Mediratta |
| 10267 | Rzecz     |
| 10269 | Hilberg   |
| 10454 | Ugarte    |
| 10481 | Grosch    |
| 10527 | Kieras    |
+-------+-----------+
10 rows in set (0.01 sec)
```

### 2.6 三表连接查询

查询所有课程的课程名和教授。

```
select distinct C.title, I.name
from instructor as I, teaches as T, course as C
```

```
where I.ID = T.ID and T.course_id = C.course_id limit 10;
```

```
+--------------------------+------------+
| title                    | name       |
+--------------------------+------------+
| Image Processing         | Romero     |
| Manufacturing            | Mingoz     |
| Elastic Structures       | Bietzk     |
| Elastic Structures       | Dale       |
| Marine Mammals           | Gustafsson |
| Drama                    | Liley      |
| The Music of the Ramones | Lembr      |
| The Music of the Ramones | Ullman     |
| Surfing                  | Dale       |
| The Music of the Ramones | Voronina   |
+--------------------------+------------+
10 rows in set (0.07 sec)
```

### 2.7 实验总结

不在 group by 子句出现的属性，可以出现在 select 子句中，但必须用聚集函数（avg, min, max, sum, count）。

在分组统计查询中，where 条件针对的是单个元组，而 having 条件针对的是 group by 子句构成的分组。

如：查询教师平均工资超过 42000 美元的系可以这样写

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

## 3 实验 1.3 数据高级查询实验

### 3.1 IN 嵌套查询

查询选了 Kean 老师的课的所有学生（学号、姓名）。

```
select `ID`, `name`
from `student`
where `ID` in
    (select `takes`.`ID`
    from `takes`, `teaches`, `instructor`
    where `takes`.`course_id` = `teaches`.`course_id` and
        `takes`.`sec_id` = `teaches`.`sec_id` and
        `takes`.`year` = `teaches`.`year` and
        `takes`.`semester` = `teaches`.`semester` and
        `teaches`.`ID` = `instructor`.`ID` and
        `instructor`.`name` = 'Kean');
```

```
limit 10;
```

结果如下：

```
+-------+------------+
| ID    | name       |
+-------+------------+
| 10267 | Rzecz      |
| 107   | Shabuno    |
| 10736 | Veselovsky |
| 10834 | More       |
| 11152 | Al-Tahat   |
| 11419 | Geronimo   |
| 11453 | Yamashita  |
| 11855 | Mendelzon  |
| 12563 | Stone      |
| 13028 | Okano      |
+-------+------------+
10 rows in set (0.02 sec)
```

### 3.2 单层 exists 嵌套查询

查询没有选 Kean 老师的课的所有学生（学号、姓名）。

```
select `ID`, `name`
from `student`
where not exists
    (select `takes`.`ID`
    from `takes`, `teaches`, `instructor`
    where `student`.`ID` = `takes`.`ID` and
        `takes`.`course_id` = `teaches`.`course_id` and
        `takes`.`sec_id` = `teaches`.`sec_id` and
        `takes`.`year` = `teaches`.`year` and
        `takes`.`semester` = `teaches`.`semester` and
        `teaches`.`ID` = `instructor`.`ID` and
        `instructor`.`name` = 'Kean');
```

结果如下：

```
+-------+------------+
| ID    | name       |
+-------+------------+
| 5144  | Abdellatif |
| 45002 | Abraham    |
| 20244 | Abu-B      |
| 83622 | Achilles   |
| 13511 | Adam       |
| 20084 | Adda       |
| 46655 | Advani     |
| 58326 | Afim       |
| 18709 | Agar       |
```

```
| 49205 | Agraz      |
+-------+------------+
10 rows in set (0.20 sec)
```

### 3.3 双层 exists 嵌套查询

查询至少选了 Manber 选过的所有课程的学生（学号、姓名）。

```
select `ID`, `name`
from `student` as S2
where not exists
    (select 1
    from `takes` as T1, `student` as S1
    where T1.`ID` = S1.`ID` and
        S1.`name` = 'Manber' and
        not exists (
            select 1
            from `takes` as T2
            where T2.`course_id` = T1.`course_id` and
                T2.`ID` = S2.`ID`
        )
    );
```

结果如下：

```
+------+--------+
| ID   | name   |
+------+--------+
| 1000 | Manber |
+------+--------+
1 row in set (0.05 sec)
```

### 3.4 from 子句中的嵌套查询

查询选课数超过 20 门的学生。

```
select S.`ID`, S.`name`, T.cnt
from `student` as S,
    (select `ID`, count(`course_id`) as cnt
    from `takes`
    group by `ID`) as T
where S.ID = T.ID and T.cnt > 20
limit 10;
```

结果如下：

```
+-------+---------+-----+
| ID    | name    | cnt |
+-------+---------+-----+
| 10033 | Zelty   |  22 |
| 1018  | Colin   |  22 |
```

```
| 10527 | Kieras  |  21 |
| 107   | Shabuno |  25 |
| 10834 | More    |  22 |
| 12078 | Knutson |  27 |
| 1367  | Ignj    |  21 |
| 14432 | Whitley |  22 |
| 14639 | Sagiv   |  21 |
| 14668 | Malinen |  23 |
+-------+---------+-----+
10 rows in set (0.07 sec)
```

### 3.5 集合查询（交）

查询 Zelty 和 Colin 都选过的所有课。

mysql 没有 intersect 运算符。好在我们可以使用 inner join 代替它。

```
select tab1.course_id, tab1.sec_id, tab1.semester, tab1.year from
(select T1.*
from `student` as S1, `takes` as T1
where S1.ID = T1.ID and S1.name = 'Zelty') as tab1
join
(select T2.*
from `student` as S2, `takes` as T2
where S2.ID = T2.ID and S2.name = 'Colin') as tab2
on tab1.`course_id` = tab2.`course_id`;
```

结果如下：

```
+-----------+--------+----------+------+
| course_id | sec_id | semester | year |
+-----------+--------+----------+------+
| 338       | 1      | Spring   | 2007 |
| 338       | 2      | Spring   | 2006 |
| 362       | 3      | Spring   | 2008 |
| 457       | 1      | Spring   | 2001 |
| 603       | 1      | Fall     | 2003 |
| 791       | 1      | Spring   | 2006 |
| 972       | 1      | Spring   | 2009 |
+-----------+--------+----------+------+
7 rows in set (0.11 sec)
```

### 3.6 集合查询（并）

查询 Zelty 和 Colin 选过的所有课。

```
(select T1.*
from `student` as S1, `takes` as T1
where S1.ID = T1.ID and S1.name = 'Zelty')
union
(select T2.*
```

```
from `student` as S2, `takes` as T2
where S2.ID = T2.ID and S2.name = 'Colin')
```

结果如下:

```
+-------+-----------+--------+----------+------+-------+
| ID    | course_id | sec_id | semester | year | grade |
+-------+-----------+--------+----------+------+-------+
| 10033 | 242       | 1      | Fall     | 2009 | B     |
| 10033 | 334       | 1      | Fall     | 2009 | C-    |
| 10033 | 338       | 1      | Spring   | 2007 | A     |
| 10033 | 338       | 2      | Spring   | 2006 | C     |
| 10033 | 352       | 1      | Spring   | 2006 | A     |
| 10033 | 362       | 3      | Spring   | 2008 | A-    |
| 10033 | 408       | 1      | Spring   | 2007 | C-    |
| 10033 | 408       | 2      | Spring   | 2003 | B+    |
| 10033 | 443       | 2      | Spring   | 2002 | C-    |
| 10033 | 445       | 1      | Spring   | 2001 | C     |
| 10033 | 457       | 1      | Spring   | 2001 | C-    |
| 10033 | 486       | 1      | Fall     | 2009 | C     |
| 10033 | 493       | 1      | Spring   | 2010 | C-    |
| 10033 | 603       | 1      | Fall     | 2003 | B     |
| 10033 | 604       | 1      | Spring   | 2009 | A-    |
| 10033 | 629       | 1      | Spring   | 2003 | B-    |
| 10033 | 679       | 1      | Spring   | 2010 | A+    |
| 10033 | 692       | 1      | Spring   | 2010 | A     |
| 10033 | 702       | 1      | Spring   | 2001 | A     |
| 10033 | 791       | 1      | Spring   | 2006 | C     |
| 10033 | 960       | 1      | Fall     | 2009 | C+    |
| 10033 | 972       | 1      | Spring   | 2009 | C+    |
| 1018  | 105       | 1      | Fall     | 2009 | A     |
| 1018  | 158       | 1      | Fall     | 2008 | A-    |
| 1018  | 192       | 1      | Fall     | 2002 | B     |
| 1018  | 200       | 2      | Fall     | 2002 | B-    |
| 1018  | 239       | 1      | Fall     | 2006 | B-    |
| 1018  | 274       | 1      | Fall     | 2002 | A+    |
| 1018  | 304       | 1      | Fall     | 2009 | B     |
| 1018  | 319       | 1      | Spring   | 2003 | C     |
| 1018  | 338       | 1      | Spring   | 2007 | A     |
| 1018  | 349       | 1      | Spring   | 2008 | A-    |
| 1018  | 362       | 3      | Spring   | 2008 | B     |
| 1018  | 401       | 1      | Fall     | 2003 | C     |
| 1018  | 421       | 1      | Fall     | 2004 | C-    |
| 1018  | 457       | 1      | Spring   | 2001 | B+    |
| 1018  | 468       | 1      | Fall     | 2005 | B     |
| 1018  | 476       | 1      | Fall     | 2010 | B+    |
| 1018  | 482       | 1      | Fall     | 2005 | A+    |
| 1018  | 581       | 1      | Spring   | 2005 | B     |
| 1018  | 599       | 1      | Spring   | 2003 | A+    |
| 1018  | 603       | 1      | Fall     | 2003 | C+    |
| 1018  | 791       | 1      | Spring   | 2006 | B     |
```

```
| 1018  | 972       | 1      | Spring   | 2009 | C-    |
+-------+-----------+--------+----------+------+-------+
44 rows in set (0.12 sec)
```

### 3.7 集合查询（差）

查询 Zelty 选过，但 Colin 没选过的所有课。
mysql 没有 except 运算符，好在我们可以使用两种方法代替 except：

- select form table1 where not in (select from table2)
- 运用在 B 不在 A 中的项用 Left Join 会填入 NULL 这一性质

```sql
select T1.*
from `student` as S1, `takes` as T1
where S1.ID = T1.ID and
    S1.name = 'Zelty' and
    T1.`course_id` not in
    (select T2.`course_id`
    from `student` as S2, `takes` as T2
    where S2.ID = T2.ID and S2.name = 'Colin')
```

```sql
select tab1.* from (
    (select T1.*
    from `student` as S1, `takes` as T1
    where S1.ID = T1.ID and
        S1.name = 'Zelty') as tab1
    left join
    (select T2.*
    from `student` as S2, `takes` as T2
    where S2.ID = T2.ID and
        S2.name = 'Colin') as tab2
    on tab1.`course_id` = tab2.`course_id`)
where tab2.ID is null;
```

用第一种方法实现，结果如下：

```
+-------+-----------+--------+----------+------+-------+
| ID    | course_id | sec_id | semester | year | grade |
+-------+-----------+--------+----------+------+-------+
| 10033 | 242       | 1      | Fall     | 2009 | B     |
| 10033 | 334       | 1      | Fall     | 2009 | C-    |
| 10033 | 352       | 1      | Spring   | 2006 | A     |
| 10033 | 408       | 1      | Spring   | 2007 | C-    |
| 10033 | 408       | 2      | Spring   | 2003 | B+    |
| 10033 | 443       | 2      | Spring   | 2002 | C-    |
| 10033 | 445       | 1      | Spring   | 2001 | C     |
| 10033 | 486       | 1      | Fall     | 2009 | C     |
| 10033 | 493       | 1      | Spring   | 2010 | C-    |
| 10033 | 604       | 1      | Spring   | 2009 | A-    |
```

```
| 10033 | 629       | 1      | Spring   | 2003 | B-    |
| 10033 | 679       | 1      | Spring   | 2010 | A+    |
| 10033 | 692       | 1      | Spring   | 2010 | A     |
| 10033 | 702       | 1      | Spring   | 2001 | A     |
| 10033 | 960       | 1      | Fall     | 2009 | C+    |
+-------+-----------+--------+----------+------+-------+
15 rows in set (0.02 sec)
```

用第二种方法实现，结果如下：

```
+-------+-----------+--------+----------+------+-------+
| ID    | course_id | sec_id | semester | year | grade |
+-------+-----------+--------+----------+------+-------+
| 10033 | 242       | 1      | Fall     | 2009 | B     |
| 10033 | 334       | 1      | Fall     | 2009 | C-    |
| 10033 | 352       | 1      | Spring   | 2006 | A     |
| 10033 | 408       | 1      | Spring   | 2007 | C-    |
| 10033 | 408       | 2      | Spring   | 2003 | B+    |
| 10033 | 443       | 2      | Spring   | 2002 | C-    |
| 10033 | 445       | 1      | Spring   | 2001 | C     |
| 10033 | 486       | 1      | Fall     | 2009 | C     |
| 10033 | 493       | 1      | Spring   | 2010 | C-    |
| 10033 | 604       | 1      | Spring   | 2009 | A-    |
| 10033 | 629       | 1      | Spring   | 2003 | B-    |
| 10033 | 679       | 1      | Spring   | 2010 | A+    |
| 10033 | 692       | 1      | Spring   | 2010 | A     |
| 10033 | 702       | 1      | Spring   | 2001 | A     |
| 10033 | 960       | 1      | Fall     | 2009 | C+    |
+-------+-----------+--------+----------+------+-------+
15 rows in set (0.01 sec)
```

## 3.8 思考题

(1) 试分析什么类型的查询可以用连接查询实现，什么类型的查询只能用嵌套查询实现?

形如

```
select * from table1, table2 where table1.xxx=table2.xxx
```

的查询可用连接查询实现。

(2) 试分析不相关子查询和相关子查询的区别。

1. 非相关子查询是独立于外部查询的子查询，子查询总共执行一次，执行完毕后将值传递给外部查询。

2. 相关子查询的执行依赖于外部查询的数据，外部查询执行一行，子查询就执行一次。

故非相关子查询比相关子查询效率高。

## 3.9 实验总结

实验中我遇到 mysql 不支持 intersect, except 语法的问题，查询网上的一些资料，知道了“mysql”还有一些方言，用其他的语句来替代 intersect, except 来完成本次实验。

据说 join 比嵌套查询要快，所以我们以后要多多用 join ，少用嵌套查询。
参考资料：https://blog.csdn.net/thor_w/article/details/68495088

# 4 实验 1.4 数据更新实验

## 4.1 insert 基本语句（插入全部列的数据）

插入一条学生记录，要求每列都给一个合理的值。

```
insert into `student`
values (99988, 'XiaoYao', 'Comp. Sci.', 0);
```

## 4.2 insert 基本语句（插入部分列的数据）

插入一条学生记录，给出必要的几个字段的值。

```
insert into `student` (`ID`, `name`, `dept_name`, `tot_cred`)
values (99988, 'XiaoYao', 'Comp. Sci.', 0);
```

## 4.3 批量数据 insert 语句

创建一个新的学生表，把所有计算机系的学生插入到学生表中。

```
create table student_comp like student; # 复制数据模式，不复制数据
insert into `student_comp`
    select * from `student` where `student`.`dept_name` = 'Comp. Sci.';
```

创建一个学生表，记录每个学生选课总数和得到 A 等级以上的课程总数。

```
create table stu2 (
    ID varchar(5) primary key,
    name varchar(20) not null,
    tot_elect int,
    tot_accept int
);
insert into stu2
select S.`ID`, S.`name`, count(distinct T1.`course_id`), count(distinct T2.`
    course_id`)
from student as S, takes as T1, takes as T2
where S.`ID` = T1.`ID` and
    S.`ID` = T2.`ID` and
    T2.`grade` is not null and
    (T2.`grade` = 'A' or T2.`grade` = 'A+')
group by S.`ID`;
```

## 4.4 update 语句（修改部分记录的部分列值）

计算机系的所有老师工资涨 10% 。
先查询原来的工资：

```
select *
from instructor
where dept_name = 'Comp. Sci.';
```

结果如下：

```
+-------+----------+------------+-----------+
| ID    | name     | dept_name  | salary    |
+-------+----------+------------+-----------+
| 3335  | Bourrier | Comp. Sci. |  79189.95 |
| 34175 | Bondi    | Comp. Sci. | 113171.27 |
+-------+----------+------------+-----------+
2 rows in set (0.01 sec)
```

```
update instructor
set salary = salary * 1.1
where dept_name = 'Comp. Sci.';
```

更新时产生错误：

```
Error Code: 1175. You are using safe update mode and you tried to update a table
    without a WHERE that uses a KEY column To disable safe mode, toggle the option
    in Preferences -> SQL Queries and reconnect.
```

这是因为 mysql 防止误更新，只需要执行以下命令，再重新执行更新命令即可。

```
set sql_safe_updates = 0;
```

执行后产生两个警告：

```
2 row(s) affected, 2 warning(s):
1265 Data truncated for column 'salary' at row 1
1265 Data truncated for column 'salary' at row 2
Rows matched: 2  Changed: 2  Warnings: 2
```

这是因为工资的精度是 2 位小数，乘以 1.1 后变为 3 位小数，自动截断。

再查询现在的工资：

```
select *
from instructor
where dept_name = 'Comp. Sci.';
```

结果如下：

```
+-------+----------+------------+-----------+
| ID    | name     | dept_name  | salary    |
+-------+----------+------------+-----------+
| 3335  | Bourrier | Comp. Sci. |  87108.95 |
| 34175 | Bondi    | Comp. Sci. | 124488.40 |
+-------+----------+------------+-----------+
2 rows in set (0.02 sec)
```

### 4.5 delete 基本语句（删除给定条件的所有记录）

删除工资高于 50000 的教授。

```
create table ins2 select * from instructor; # 先复制一份数据库用于删除
delete from ins2 where salary > 50000;
```

删除时产生错误：

```
Error Code: 1175. You are using safe update mode and you tried to update a table
    without a WHERE that uses a KEY column To disable safe mode, toggle the option
    in Preferences -> SQL Queries and reconnect.
```

这是因为 mysql 防止误删除，只需要执行以下命令，再重新执行删除命令即可。

```
set sql_safe_updates = 0;
```

### 4.6 实验总结

实验不难，不过 update, delete 这个防护开关我真的觉得很赞 ~

现在的 mysql 8.0 版本已经有 sql_safe_updates 这个开关啦！而且默认还是开的！有这个开关之后，所有的 update, delete 操作必须要有 where 子句，且必须指定 primary key （主键）才能删除。想当年我用 mysql 5.6 的时候，一手贱忘记加 where ，结果整列都被改掉了……哭瞎 QAQ

## 5 实验 1.5 视图实验

### 5.1 创建视图（省略视图列名）

创建一个学生选课视图，要求列出学生学号、姓名、科目、学分、上课时间、上课地点等信息。

```
create view stu_takes as
    select S.`ID`, S.`name`, T.`sec_id`, T.`semester`, T.`year`, C.`title`, C.`
        credits`, SE.`building`, SE.`room_number`, SE.`time_slot_id`
    from `student` as S, `takes` as T, `course` as C natural join `section` as SE
    where S.`ID` = T.`ID` and
        T.`course_id` = C.`course_id`;
```

### 5.2 创建视图（不能省略视图列名的情况）

创建一个学生视图，要求列出学生学号、姓名、已修课程数。

```
create view stu2(ID, name, cnt) as
    select S.`ID`, S.`name`, count(T.`course_id`)
    from `student` as S, `takes` as T
    where S.`ID` = T.`ID`
    group by S.`ID`;
```

### 5.3 创建视图（with check option）

创建一个选课视图，单独列出学号为 1000 的选课记录，然后通过该视图分别增加、删除、修改一条记录，验证 with check option 是否起作用。

```
create view takes2 as
    select * from takes where `ID` = 1000
with check option;
```

```
insert into takes2 values
    ('1000', '105', '2', 'Fall', 2002, 'F');
```

运行结果：1 row(s) affected

```
insert into takes2 values
    ('1001', '105', '2', 'Fall', 2002, 'F');
```

运行结果：Error Code: 1369. CHECK OPTION failed 'lab.takes2'

这是因为，视图 takes2 打开了 check option ，选择了 'ID' = 1000 的记录，但新增的记录不满足 'ID' = 1000 ，故返回错误。

```
update `takes2`
set `grade` = 'A'
where `ID` = '1000' and
    `course_id` = '239' and
    `sec_id` = '1' and
    `semester` = 'Fall' and
    `year` = '2006';
```

运行结果：

1 row(s) affected

Rows matched: 1 Changed: 1 Warnings: 0

```
update `takes2`
set `ID` = '1001'
where `ID` = '1000' and
    `course_id` = '239' and
    `sec_id` = '1' and
    `semester` = 'Fall' and
    `year` = '2006';
```

运行结果：Error Code: 1369. CHECK OPTION failed 'lab.takes2'

原因同上。

```
delete from takes2 where
    ID = '1000' and
    course_id = '105' and
    sec_id = '2' and
    semester = 'Fall' and
    year = 2002 and
    grade = 'F';
```

运行结果：1 row(s) affected

### 5.4 可更新的视图（行列子集视图）

创建一个选课视图，单独列出学号为 1000 的选课记录，然后通过该视图分别增加、删除、修改一条记录，验证该视图是否是可更新的。

```
create view takes2 as
    select * from takes where `ID` = 1000
;
```

```
insert into takes2 values
    ('1000', '105', '2', 'Fall', 2002, 'F');
```

运行结果：1 row(s) affected

```
update `takes2`
set `grade` = 'A'
where `ID` = '1000' and
    `course_id` = '239' and
    `sec_id` = '1' and
    `semester` = 'Fall' and
    `year` = '2006';
```

运行结果：
1 row(s) affected
Rows matched: 1 Changed: 1 Warnings: 0

```
delete from takes2 where
    ID = '1000' and
    course_id = '105' and
    sec_id = '2' and
    semester = 'Fall' and
    year = 2002 and
    grade = 'F';
```

运行结果：1 row(s) affected

### 5.5 不可更新的视图

(2) 中的视图是可更新的吗？通过 SQL 更新语句加以验证，并说明原因。

```
create view stu2(ID, name, cnt) as
    select S.`ID`, S.`name`, count(T.`course_id`)
    from `student` as S, `takes` as T
    where S.`ID` = T.`ID`
    group by S.`ID`;
```

```
insert into stu2 values ('99991', 'Yaoyao', 200);
```

运行结果：
Error Code: 1471. The target table stu2 of the INSERT is not insertable-into
这是因为这个视图的第三列是聚合函数。

## 5.6 删除视图

创建视图 stu1 ，要求列出学号小于'50000' 的学生的所有信息；
在视图 stu1 的基础上创建视图 (2) 。
使用 restrict 选项删除视图 stu1 ，观察现象并解释原因。
使用 cascade 选项删除视图 stu1 ，观察现象并检查 stu2 是否存在，解释原因。

```
create view stu1 as
    select *
    from student
    where ID < '50000';

create view stu2(ID, name, cnt) as
    select S.`ID`, S.`name`, count(T.`course_id`)
    from `stu1` as S, `takes` as T
    where S.`ID` = T.`ID`
    group by S.`ID`;
```

```
drop view stu1 restrict;
```

用 restrict 选项删除后，stu2 视图依然存在。对 stu2 执行 select 操作：

```
SELECT * FROM stu2;
```

Error Code: 1356. View 'lab.stu2' references invalid table(s) or column(s) or function(s) or definer/invoker of view lack rights to use them

```
create view stu1 as
    select *
    from student
    where ID < '50000';
```

重建 stu1 ，再次对 stu2 执行 select 操作：

```
SELECT * FROM stu2;
```

874 row(s) returned

```
drop view stu1 cascade;
```

用 cascade 选项删除后，stu2 视图依然存在。对 stu2 执行 select 操作：

```
SELECT * FROM stu2;
```

Error Code: 1356. View 'lab.stu2' references invalid table(s) or column(s) or function(s) or definer/invoker of view lack rights to use them

查阅 Mysql 文档 (https://dev.mysql.com/doc/refman/8.0/en/drop-view.html) 知，Mysql 忽略 restrict 和 cascade 。原文：RESTRICT and CASCADE, if given, are parsed and ignored.

## 5.7 实验总结

视图本身只是一个查询语句，而不是一个表。每次选择视图，实际上是执行相对应的查询语句。
视图的删除在 Mysql 中不区分 restrict 和 cascade 。

# 6 实验 1.6 索引实验

## 6.1 创建唯一索引

在学生表的 ID 字段上创建唯一索引。

```
1 create unique index studentID_index on student(ID);
```

0 row(s) affected
索引创建成功。

```
1 Index: studentID_index
2 Definition:
3
4 Type    BTREE
5 Unique  Yes
6 Columns ID
```

## 6.2 创建函数索引

在学生表的 name 字段上按字符串长度创建索引。

```
1 create index name_len_index on student(length(`name`));
```

Error Code: 1064. You have an error in your SQL syntax; check the manual that corresponds to your MySQL server version for the right syntax to use near '`name`))' at line 1
很遗憾，Mysql 没有函数索引功能。

## 6.3 创建复合索引

在学生表的 ID, name 字段上创建索引。

```
1 create index idx on student(ID, name);
```

0 row(s) affected
索引创建成功。

```
1 Index: idx
2 Definition:
3
4 Type    BTREE
5 Unique  No
6 Columns ID
7     name
```

## 6.4 分析某个 SQL 查询语句时是否使用了索引

```
1 explain select * from student where name = 'Manber';
```

结果如下:

```
+----+-------------+---------+------------+------+---------------+
    ------+---------+-------+------+----------+-------+
| id | select_type | table   | partitions | type | possible_keys |
     key  | key_len | ref   | rows | filtered | Extra |
+----+-------------+---------+------------+------+---------------+
    ------+---------+-------+------+----------+-------+
|  1 | SIMPLE      | student | NULL       | ref  | idx           |
     idx  | 82      | const |    1 |   100.00 | NULL  |
+----+-------------+---------+------------+------+---------------+
    ------+---------+-------+------+----------+-------+
1 row in set, 1 warning (0.02 sec)
```

可以看到，查询语句是使用了 idx 这个索引的。

## 6.5 删除索引

删除在学生表的 ID 字段上创建的唯一索引。

```
drop index studentID_index on student;
```

## 6.6 实验总结

索引能为查询加速，所以我们才会创建索引。主键在 mysql 里默认是索引。函数索引在 mysql 中不可用。

0 row(s) affected

索引删除成功。