A Gentler Introduction

to MySQL Database Programming

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Abstract

This is Part II of the lab notes prepared for the students of CS3600 Introduction to the Database Systems for Fall 2015. This part introduces some basic MySQL structures, using the Student Registration Database as contained in [1, §3.2].

We show how to define and populate tables in such a database. We then discuss most of the queries as suggested in [1, §5.2], test them out with MySQL (ver 4.1.14), and show the results.

We briefly discuss the use of view in database programming.

We also present a general PhP script that can be used to test out any query related to the above database.

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1 Basic MySQL commands

Assume your MySQL account name is j_doe, you can log into MySQL by entering your account information in the turing prompt via the following interaction:

```
/home/zshen > mysql -p
Enter password:
Welcome to the MySQL monitor. Commands end with ; or \g.
Your MySQL connection id is 1643
Server version: 5.1.73 Source distribution
```

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Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

```
mysql>
```

When everything goes smoothly, you should get the last MySQL prompt as shown and you are ready to use MySQL.

Below are some of the basic MySQL commands you need to deal with it. For more of a large collection of MySQL commands, please refer to [2].

- You should have already a database whose name is the same as your login name. In general, the following lets you find out all the existing databases:

---

1. Your personal account for MySQL has been set on turing, and the relevant information has also been sent to your email account. If you can’t find it, or you recently added into this course, please come to talk to me.
mysql> show databases;
+--------------+
| Database     |
+--------------+
| another      |
| fear         |
| geography    |
| mysql        |
| registration |
| shentest     |
| test         |
+--------------+
7 rows in set (0.00 sec)

• Before using a database, you have to create it first. For example, the following creates the database testDB:

mysql> create database testDB;
Query OK, 1 row affected (0.00 sec)

mysql> show databases;
+--------------+
| Database     |
+--------------+
| another      |
| fear         |
| geography    |
| mysql        |
| registration |
| shentest     |
| test         |
| testdb       |
+--------------+
8 rows in set (0.00 sec)

Note: You might not be able to create a database with MySQL since you don’t have this specific access right, when you get the following message:

ERROR 1044 (42000): Access denied for user 'j_doe'@'%' to database 'registration'

In this case, you just add in all the tables into your database, e.g., j_doe.
- You also have to specify which database to use, before using it. For example, if you want to use the registration database, you have to enter the following:

```sql
mysql> use registration;
Database changed
```

- Show all the tables in the current database that you have chosen to use:

```sql
mysql> show tables;
```

```
+------------------------+
| Tables_in_registration |
------------------------+
| course                |
| hardclass             |
| professor             |
| student               |
| teaching              |
| transcript            |
+------------------------+
6 rows in set (0.00 sec)
```

- Before using a database table, you have to create it first. The following creates a table aTable:

```sql
mysql> create table aTable (
    -> old char(10),
    -> another integer);
Query OK, 0 rows affected (0.08 sec)
```

aTable looks like the following:

```sql
mysql> desc aTable;
```

```
| Field | Type    | Null | Key | Default | Extra |
+-------+---------+------|-----|---------+-------|
| old   | char(10)| YES  |     | NULL    |       |
| another| int(11) | YES  |     | NULL    |       |
+-------+---------+------|-----|---------+-------|
2 rows in set (0.00 sec)
```

- It is pretty easy to make mistakes when creating a table. When this happens, we can use the quite flexible Alter Table command to correct them. For example, the following changes the definition of column old of a table aTable to new Integer, and make it into the primary key.
mysql> alter table aTable change old new integer not null primary key;
Query OK, 0 rows affected (0.16 sec)
Records: 0  Duplicates: 0  Warnings: 0

It is now indeed changed.

mysql> desc aTable;
+---------+---------+------+-----+---------+-------+
<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Null</th>
<th>Key</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>new</td>
<td>int(11)</td>
<td></td>
<td>PRI</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>another</td>
<td>int(11)</td>
<td>YES</td>
<td></td>
<td>NULL</td>
<td></td>
</tr>
</tbody>
</table>
+---------+---------+------+-----+---------+-------+
2 rows in set (0.00 sec)

Note: Alter table has a very rich syntax structure, which allows us to do many different things. For example, the following changes the name of a table Student to student.

mysql> show tables;
+------------------------+
| Tables_in_registration |
+------------------------+
| ClassAce               |
| ClassEnrollment        |
| ClassFailures          |
| HardClass              |
| Student                |
| course                 |
| easyClass              |
| hardclass              |
| professor              |
| teaching               |
| tempT                  |
| transcript             |
| v                      |
+------------------------+
13 rows in set (0.00 sec)

mysql> alter table Student rename to student;
Query OK, 0 rows affected (0.67 sec)
mysql> show tables;
+------------------------+
| Tables_in_registration |
+------------------------+
| ClassAce               |
| ClassEnrollment        |
| ClassFailures          |
| HardClass              |
| course                 |
| easyClass              |
| hardclass              |
| professor              |
| student                |
| teaching               |
| tempT                  |
| transcript             |
| v                      |
+------------------------+
13 rows in set (0.00 sec)

For more details, please do check [2].

- You sometimes want to delete a table structure. The following shows how to drop a table t.

  mysql> drop table t;
  Query OK, 0 rows affected (0.12 sec)

  Notice that this operation will delete everything, both the structure and the content, of the table to be dropped. Thus, it is the opposite of both create table and insert into.

  If you just want to delete some rows from a table, the syntax is the following:

    delete from
    where

  For example, if you just want to delete a row from the student table such that its Id is ‘111111111’, you just need to say the following:

    delete from Student
    where Id='111111111';
We often do something in one system, then switch it to a production system, thus the need for saving all the stuff we do and reproduce it somewhere else. This is called a dumping.

The following example shows how to dump all the tables of a database, shentest, its structure and content, into shentestdump.sql, an sql script, under c:/temp, which can be later executed in turing, for example, to restore the whole thing.

C:\Program Files\MySQL\MySQL Server 4.1\bin>
mysqldump -u root -p shentest > c:/temp/shentestdump.sql
Enter password: ********

Note: This has to run at the system prompt, such as DOS or turing.

1.1 A GUI interface

It is far easier to use a GUI interface to complete some of the database operations. One of the better and more popular GUI interface for the MySQL/PHP combo is PhPMySQLAdmin, which is available on turing.

To activate this interface in turing, just enter http://turing.plymouth.edu/mysql/ in the browser. You need your mySQL log-in information to get in.

If stored locally, it can be launched by opening the following page, if all the files related to the PhPMySQLAdmin software is collected in a folder PhPMySQLAdmin and placed under Apache:Apach2:htdocs:

http://localhost/phpMyAdmin/

2 Table definition and population

2.1 The Student table

1. Structure: Figure 3.6,[1, pp. 43]

   Student (Id: INT, Name: STRING, Address: STRING, Status: STRING)
   Key: {Id}

2. SQL code: pp. 49

   CREATE TABLE Student (
       Id INTEGER,
       Name Char(20) Not Null,
       Address Char(50),
       Status STRING
   )

    7
Status Char(10) Default 'freshman'

PRIMARY KEY (Id));

3. MySQL code:

create table Student (  
   Id INT Not Null Primary key,  
   Name Char(20) Not Null,  
   Address Char(50),  
   Status Char(20) default 'freshman');

mysql> desc Student;
+---------+----------+------+-----+----------+-------+
| Field  | Type     | Null | Key | Default | Extra |
+---------+----------+------+-----+----------+-------+
| Id     | int(11)  |      | PRI | 0        |       |
| Name   | char(20) |      |     |          |       |
| Address| char(50) | YES  | NULL|          |       |
| Status | char(20) | YES  |      | freshman |       |
+---------+----------+------+-----+----------+-------+
4 rows in set (0.01 sec)

4. Data: Figure 2.1. [1, pp. 14]

Insert into Student (Id, Name, Address, Status)  
   Values (111111111, 'Jane Doe', '123 Main St.', 'freshman');

Insert into Student (Id, Name, Address, Status)  
   Values (666666666, 'Jesoph Public', '666 Hollow Rd.', 'sop homore');

Insert into Student (Id, Name, Address, Status)  
   Values (111223344, 'Mary Smith', '1 Lake St.', 'freshman');

Insert into Student (Id, Name, Address, Status)  
   Values (987654321, 'Bart Simpson', 'Fox 5 Tv', 'senior');

Insert into Student (Id, Name, Address, Status)  
   Values (023456789, 'Homer Simpson', 'Fox 5 Tv', 'senior');

Insert into Student (Id, Name, Address, Status)  
   Values (123454321, 'Joe Blow', '6 Yard Ct.', 'junior');
Notice that the first 0 does not show;

```
mysql> select * from Student;
+-----------+---------------+----------------+-----------+
| Id   | Name          | Address        | Status    |
| +-----+---------------+----------------+-----------+
| 23456789 | Homer Simpson  | Fox 5 Tv       | senior    |
| 111111111 | Jane Doe      | 123 Main St.   | freshman  |
| 111223344 | Mary Smith    | 1 Lake St.     | freshman  |
| 123454321 | Joe Blow      | 6 Yard Ct.     | junior    |
| 666666666 | Jesoph Public | 666 Hollow Rd. | sophomore |
| 987654321 | Bart Simpson  | Fox 5 Tv       | senior    |
+-----+---------------+----------------+-----------+
6 rows in set (0.00 sec)
```

### 2.2 The Professor table

1. **Structure:** Figure 3.6, [1, pp. 43]

   Professor (Id: INT, Name: STRING, DeptId: DEPTS)
   
   Key: {Id}

2. **SQL code:** It is not given in the book, but can be found, e.g., in the example given in pp. 39.

   ```sql
   CREATE TABLE Professor (  
     Id   Integer,  
     Name Char(20) Not Null,  
     DeptId Char(2) Not Null,  
     PRIMARY KEY (Id));
   ```

3. **MySQL code:**

   ```sql
   create table Professor (  
     Id INT Not Null Primary key,  
     Name Char(20) Not Null,  
     DeptId Char(4) Not Null);
   ```

   Note: The following changes the type of DeptId.
alter table Professor change DeptId DeptId Char(4);

mysql> desc Professor;
+--------+----------+------+-----+---------+-------+
| Field | Type     | Null | Key | Default | Extra |
+--------+----------+------+-----+---------+-------+
| Id     | int(11)  |      | PRI | 0       |       |
| Name   | char(20) |      |     |         |       |
| DeptId | char(4)  | YES  | NULL| NULL    |       |
+--------+----------+------+-----+---------+-------+
3 rows in set (0.00 sec)

4. Data: Figure 3.5, [1, pp. 39]

Insert into Professor (Id, Name, DeptId)
Values (101202303, 'John Smyth', 'CS');

Insert into Professor (Id, Name, DeptId)
Values (783432188, 'Adrian Jones', 'MGT');

Insert into Professor (Id, Name, DeptId)
Values (121232343, 'David Jones', 'EE');

Insert into Professor (Id, Name, DeptId)
Values (864297351, 'Qi Chen', 'MAT');

Insert into Professor (Id, Name, DeptId)
Values (555666777, 'Mary Doe', 'CS');

Insert into Professor (Id, Name, DeptId)
Values (009406321, 'Jacob Taylor', 'MGT');

Insert into Professor (Id, Name, DeptId)
Values (900120450, 'Ann White', 'MAT');

mysql> select * from Professor;
+-----------+--------------+--------+
| Id        | Name         | DeptId |
+-----------+--------------+--------+
| 9406321   | Jacob Taylor | MGT    |
| 101202303 | John Smyth   | CS     |
| 121232343 | David Jones  | EE     |
+-----------+--------------+--------+
2.3 The Course table

1. Structure: Figure 3.6,[1, pp. 43]

Course (DeptId: DEPTS, CrsName: STRING, CrsCode: COURSES)
Key: {CrsCode}, {DeptId,CrsName}

Notice this table comes with two key constraints.

2. SQL code: It is not given in the book, but is suggested with the attached data.

Create table Course (  
  CrsCode Char(6),  
  DeptId Char(4)  
  CrsName Char(20),  
  Descr Char(100),  
  Primary key (CrsCode),  
  Unique (DeptId,CrsName))

3. MySQL code:

Create table Course (  
  CrsCode Char(6) Not Null Primary key,  
  DeptId Char(4) Not Null,  
  CrsName Char(20) Not Null,  
  Descr Char(100),  
  CONSTRAINT course_index UNIQUE (DeptId, CrsName));

mysql> desc Course;
+---------+-----------+------+-----+---------+-------+
| Field   | Type      | Null | Key  | Default | Extra |
+---------+-----------+------+-----+---------+-------+
| CrsCode | char(6)   |      | PRI  |         |       |
| DeptId  | char(4)   |      | MUL  |         |       |
| CrsName | char(20)  |      |      |         |       |
| Descr   | char(100) | YES  | NULL |         |       |
+---------+-----------+------+-----+---------+-------+
4 rows in set (0.00 sec)
Note: Below shows how to change the name of a column. The essence is that the primary key part should not be used, as pointed out by one MySQL user.

```sql
mysql> alter table Course change CosCode CrsCode Char(6) Not Null Primary key;
ERROR 1068 (42000): Multiple primary key defined
mysql> alter table course change CosCode CrsCode Char(6) Not Null;
Query OK, 0 rows affected (0.16 sec)
Records: 0  Duplicates: 0  Warnings: 0

mysql> desc Course;
```

```
+---------+-----------+------+-----+---------+-------+
| Field   | Type      | Null | Key | Default | Extra |
+---------+-----------+------+-----+---------+-------+
| CrsCode | char(6)   |      | PRI |         |       |
| DeptId  | char(4)   |      | MUL |         |       |
| CrsName | char(20)  |      |     |         |       |
| Descr   | char(100) | YES  | NULL|         |       |
+---------+-----------+------+-----+---------+-------+
4 rows in set (0.00 sec)
```

4. **Data:** Figure 3.5, [1, pp. 39]

```sql
Insert into Course (CrsCode, DeptId, CrsName, Descr)
Values ('CS305', 'CS', 'Database Systems.',
        'On the road to high-paying job');

Insert into Course (CrsCode, DeptId, CrsName, Descr)
Values ('CS315', 'CS', 'Transaction Processing',
        'Recover from your worst crashes');

Insert into Course (CrsCode, DeptId, CrsName, Descr)
Values ('MGT123', 'MGT', 'Market Analysis', 'Get rich quick');

Insert into Course (CrsCode, DeptId, CrsName, Descr)
Values ('EE101', 'EE', 'Electronic Circuits',
        'Build your own computer');

Insert into Course (CrsCode, DeptId, CrsName, Descr)
Values ('MAT123', 'MAT', 'Algebra',
        'The world where 2+2=5');
```
mysql> select * from Course;
+---------+--------+----------------------+---------------------------------+
<table>
<thead>
<tr>
<th>CrsCode</th>
<th>DeptId</th>
<th>CrsName</th>
<th>Descr</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS305</td>
<td>CS</td>
<td>Database System</td>
<td>On the road to high-paying job</td>
</tr>
<tr>
<td>CS315</td>
<td>CS</td>
<td>Transaction Processing</td>
<td>Recover from your worst crashes</td>
</tr>
<tr>
<td>EE101</td>
<td>EE</td>
<td>Electronic Circuits</td>
<td>Build your own computer</td>
</tr>
<tr>
<td>MAT123</td>
<td>MAT</td>
<td>Algebra</td>
<td>There world where 2+2=5</td>
</tr>
<tr>
<td>MGT123</td>
<td>MGT</td>
<td>Market Analysis</td>
<td>Get rich quick</td>
</tr>
</tbody>
</table>
+---------+--------+----------------------+---------------------------------+
5 rows in set (0.05 sec)

2.4 The Transcript table

1. **Structure**: Figure 3.6, [1, pp. 43]

   Transcript (CrsCode: COURSES, StudId: INT, Grade: GRADES, Semester: SEMESTERS)
   
   Key: {StudId,CrsCode,Semester}

2. **SQL code**: Query 3.2 [1, pp. 52]

   Create table Transcript (  
   StudId Integer,  
   CrsCode Char(6),  
   Semester Char(6),  
   Grade Char(1),  
   Check (Grade in ('A','B','C','D','F')),  
   Check (StudId>0 AND StudId<100000))

3. **SQL code**: with foreign keys, in pp. 94. Notice that it also contains a foreign key on semester table, but that table does not exist, thus deleted in the mysql definition.

   Create table Transcript (  
   StudId Integer,  
   CrsCode Char(6),  
   Semester Char(6),  
   Grade Char(1),  
   Primary key (StudId, CrsCode, Semester),  
   Foreign key (StudId) references Student(Id),  
   Foreign key (CrsCode) references Course(CrsCode)  
   Foreign key (Semester) references Semester (SemCode)

4. **MySQL code**: 

13
Create table Transcript(
  StudId INT Not Null,
  CrsCode Char(6) Not Null,
  Semester Char(6) Not Null,
  Grade Char(1),
  Primary key (StudId, CrsCode, Semester),
  Foreign key (StudId) references Student(Id),
  Foreign key (CrsCode) references Course(CrsCode),
  Constraint grade_condition Check (Grade in ('A','B','C','D','F')),
  Constraint id_range Check (StudId>0 AND StudId<100000));

mysql> desc Transcript;
+----------+---------+------+-----+---------+-------+
<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Null</th>
<th>Key</th>
<th>Default</th>
<th>Extra</th>
</tr>
</thead>
<tbody>
<tr>
<td>StudId</td>
<td>int(11)</td>
<td></td>
<td>PRI</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>CrsCode</td>
<td>char(6)</td>
<td></td>
<td>PRI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semester</td>
<td>char(6)</td>
<td></td>
<td>PRI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>char(1)</td>
<td>YES</td>
<td></td>
<td>NULL</td>
<td></td>
</tr>
</tbody>
</table>
+----------+---------+------|-----|---------+-------+
4 rows in set (0.00 sec)

5. Data: Figure 3.5, [1, pp. 39]

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (666666666, 'MGT123', 'F1994', 'A');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (666666666, 'EE101', 'S1991', 'B');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (666666666, 'MAT123', 'F1997', 'B');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (987654321, 'CS305', 'F1995', 'C');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (987654321, 'MGT123', 'F1994', 'B');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (123454321, 'CS315', 'F1997', 'A');
Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (123454321, 'CS305', 'F1995', 'A');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (123454321, 'MAT123', 'S1996', 'C');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (023456789, 'EE101', 'F1995', 'B');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (023456789, 'CS305', 'S1996', 'A');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (111111111, 'EE101', 'F1997', 'A');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (111111111, 'MAT123', 'F1997', 'B');

Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (111111111, 'MGT123', 'F1997', 'B');

mysql> select * from Transcript;

<table>
<thead>
<tr>
<th>StudId</th>
<th>CrsCode</th>
<th>Semester</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>23456789</td>
<td>CS305</td>
<td>S1996</td>
<td>A</td>
</tr>
<tr>
<td>23456789</td>
<td>EE101</td>
<td>F1995</td>
<td>B</td>
</tr>
<tr>
<td>111111111</td>
<td>EE101</td>
<td>F1997</td>
<td>A</td>
</tr>
<tr>
<td>111111111</td>
<td>MAT123</td>
<td>F1997</td>
<td>B</td>
</tr>
<tr>
<td>111111111</td>
<td>MGT123</td>
<td>F1997</td>
<td>B</td>
</tr>
<tr>
<td>123454321</td>
<td>CS305</td>
<td>F1995</td>
<td>A</td>
</tr>
<tr>
<td>123454321</td>
<td>CS315</td>
<td>F1997</td>
<td>A</td>
</tr>
<tr>
<td>123454321</td>
<td>MAT123</td>
<td>S1996</td>
<td>C</td>
</tr>
<tr>
<td>666666666</td>
<td>EE101</td>
<td>S1991</td>
<td>B</td>
</tr>
<tr>
<td>666666666</td>
<td>MAT123</td>
<td>F1997</td>
<td>B</td>
</tr>
<tr>
<td>666666666</td>
<td>MGT123</td>
<td>F1994</td>
<td>A</td>
</tr>
<tr>
<td>987654321</td>
<td>CS305</td>
<td>F1995</td>
<td>C</td>
</tr>
<tr>
<td>987654321</td>
<td>MGT123</td>
<td>F1994</td>
<td>B</td>
</tr>
</tbody>
</table>

13 rows in set (0.00 sec)

Notice that the following won’t work, as it violates a foreign key constraint:
Insert into Transcript (StudId, CrsCode, Semester, Grade)
Values (111111111, 'MGT456', 'F1997', 'B');

mysql> Insert into Transcript (StudId, CrsCode, Semester, Grade)
-> Values (111111111, 'MGT456', 'F1997', 'B');
ERROR 1216 (23000): Cannot add or update a child row:
a foreign key constraint fails

2.5 The Teaching table

1. Structure: Figure 3.6,[1, pp. 43]

   Teaching (ProfId:Integer, CrsCode:String, Semester:String)
   Key: {CrsCode,Semester}

2. SQL code: [1, pp. 54]

   Create table Teaching (ProfId Integer,
   CrsCode Char(6),
   Semester Char(6),
   Primary key (CrsCode,Semester),
   Foreign key (CrsCode) references Course,
   Foreign key (ProfId) references (Professor(Id)))

3. SQL code with triggers, [1, pp. 57]. Notice that a single course can be taught by
   multiple professors in different semester. The primary constraint seems to enforce that
   only one section will be offered in one semester, thus

   • both CrsCode and Semester attributes must be declared Not Null; and
   • you can’t enter two rows with the same values for those two attributes. For
     example, the first and the fourth rows in pp. 40 can’t be entered. When you
     tried, the following message is returned.

     mysql> Insert into teaching (ProfId, CrsCode, Semester)
     -> Values (864297531, 'MGT123', 'F1994');
     ERROR 1062 (23000): Duplicate entry 'MGT123-F1994' for key 1

     This is an issue, since it is not consistent with the data to be entered in pp. 40,
     although it does not seemingly violate a user constraint.

   • Another point is that the no action option for delete, which is called restrict in the
     MySQL code since it does not allow a row to be deleted if it matches a condition.
Create table Teaching (  
    ProfId    Integer,  
    CrsCode   Char(6),  
    Semester  Char(6),  
    Primary Key (CrsCode,Semester),  
    Foreign key (ProfId) reference Professor (Id)  
        On delete No action  
        On Update Cascade,  
    Foreign key (CrsCode) references Course(CrsCode)  
        On Delete Set null  
        On Update Cascade)

4. MySQL code:

Create table Teaching (  
    ProfId    Integer,  
    CrsCode   Char(6) Not Null,  
    Semester  Char(6) Not Null,  
    Primary Key (CrsCode,Semester),  
    Foreign key (ProfId) references Professor (Id)  
        On Delete restrict  
        On Update Cascade,  
    Foreign key (CrsCode) references Course(CrsCode)  
        On Delete Set null  
        On Update Cascade);

mysql> desc Teaching;
+----------+---------+------+-----+---------+-------+
| Field    | Type    | Null | Key | Default | Extra |
|----------+---------+------|-----|--------|-------|
| ProfId   | int(11) | YES  | MUL | NULL   |       |
| CrsCode  | char(6) | NO   | PRI | NULL   |       |
| Semester | char(6) | NO   | PRI | NULL   |       |
+----------+---------+------|-----|--------|-------+
3 rows in set (0.01 sec)

5. Data: Figure 3.5, [1, pp. 39]

Insert into Teaching (ProfId, CrsCode, Semester)  
    Values (009406321, 'MGT123', 'F1994');
Insert into Teaching (ProfId, CrsCode, Semester)
Values (121232343, 'EE101', 'S1991');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (555666777, 'CS305', 'F1995');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (101202303, 'CS315', 'F1997');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (900120450, 'MAT123', 'S1996');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (121232343, 'EE101', 'F1995');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (101202303, 'CS305', 'S1996');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (900120450, 'MAT123', 'F1997');

Insert into Teaching (ProfId, CrsCode, Semester)
Values (783432188, 'MGT123', 'F1997');

mysql> select * from Teaching;
+-----------+---------+----------+
| ProfId    | CrsCode | Semester |
|-----------+---------+----------|
| 9406321   | MGT123  | F1994    |
| 101202303 | CS305   | S1996    |
| 101202303 | CS315   | F1997    |
| 121232343 | EE101   | F1995    |
| 121232343 | EE101   | S1991    |
| 555666777 | CS305   | F1995    |
| 783432188 | MGT123  | F1997    |
| 900120450 | MAT123  | F1997    |
| 900120450 | MAT123  | S1996    |
+-----------+---------+----------+
9 rows in set (0.00 sec)
Labwork 2:

1. Create and populate all the aforementioned tables in your MySQL account.

2. Create and populate the following tables:

   - **Supplier**

     `Supplier(SupplierId:String, SName:String, Status:Integer, City:String)  
     Key: {SupplierId}`

     | SupplierId | SName | Status | City       |
     |------------|-------|--------|------------|
     | S1         | Smith | 20     | London     |
     | S2         | Jones | 10     | Paris      |
     | S3         | Blake | 30     | Paris      |
     | S4         | Clark | 20     | London     |
     | S5         | Adams | 30     | Athens     |

   - **Part**

     `Part(PartId:String, PName:String, Color:String, Weight:Float, City:String)  
     Key: {PartId}`

     | PartId | PName | Color | Weight | City       |
     |--------|-------|-------|--------|------------|
     | P1     | Nut   | Red   | 12.0   | London     |
     | P2     | Bolt  | Green | 17.0   | Paris      |
     | P3     | Screw | Blue  | 17.0   | Rome       |
     | P4     | Screw | Red   | 14.0   | London     |
     | P5     | Cam   | Blue  | 12.0   | Paris      |
     | P6     | Cog   | Red   | 19.0   | London     |

   - **SupplyPart**

     `SupplyPart(SupplierId:String, PartId:String, Quantity:Integer)  
     Key: {SupplierId, PartId}`

     | SupplierId | PartId | Quantity |
     |------------|--------|----------|
     | S1         | P1     | 300      |
     | S1         | P2     | 200      |
     | S1         | P3     | 400      |
     | S1         | P4     | 200      |
     | S1         | P5     | 100      |
     | S1         | P6     | 100      |
     | S2         | P1     | 300      |
     | S2         | P2     | 400      |
     | S3         | P2     | 200      |
     | S4         | P2     | 200      |
     | S4         | P4     | 300      |
     | S4         | P5     | 400      |
3 SQL Queries

The following examples are taken from [1, §5.2].

3.1 Simple queries

5.5. Get the names of all the professors in the EE department.

(a) Relational algebraic expression.

\[ \pi_{\text{Name}}(\sigma_{\text{DeptId}='EE'}(\text{Professor})) \]

(b) MySQL code;

\begin{verbatim}
Select P.Name From Professor P Where DeptID='EE'
\end{verbatim}

mysql> Select P.Name From Professor P Where DeptID='EE';
+-------------+
| Name        |
+-------------+
| David Jones |
+-------------+
1 row in set (0.00 sec)

5.6. Get the names of all the professors who taught in Fall 1994.

(a) Relational algebraic expression.

\[ \pi_{\text{Name}}(\text{Professor} \bowtie_{\text{ProfId}} (\sigma_{\text{Semester}='F1994'}(\text{Teaching}))) \] (5.7)

(b) MySQL code;

\begin{verbatim}
Select P.Name From Professor P, Teaching T Where P.Id=T.ProfId And T.Semester='F1994'
\end{verbatim}

mysql> Select P.Name From Professor P, Teaching T Where P.Id=T.ProfId And T.Semester='F1994';
+--------------+
| Name         |
+--------------+
| Jacob Taylor |
+--------------+
1 row in set (0.08 sec)

We can verify the above result as follows:
5.10. Get the names of all the course taught in fall 1995 together with the names of these professors who taught them.

(a) Relational algebraic expression.

\[ \pi_{\text{CrsName}, \text{Name}}(\sigma_{\text{Id}=\text{ProfId}} \text{ And Teaching.CrsCode=Course.CrsCode And Semester}='\text{F1995}} \text{(Professor } \times \text{Teaching } \times \text{Course})) \]

(b) MySQL code;

```
Select c.CrsName, P.Name From Professor P, Teaching T, Course C
Where T.Semester='F1995' And P.Id=T.ProfId And T.CrsCode=C.CrsCode
```
mysql> Select c.CrsName, P.Name From Professor P, Teaching T, Course C
      -> Where T.Semester='F1995' And P.Id=T.ProfId And T.CrsCode=C.CrsCode;

+---------------------+-------------+
| CrsName             | Name        |
|---------------------+-------------|
| Database System     | Mary Doe    |
| Electronic Circuits | David Jones |
+---------------------+-------------+
2 rows in set (0.03 sec)

This result can be checked out with the following data.

mysql> select * from Teaching;

+-----------+---------+----------+
| ProfId    | CrsCode | Semester |
|-----------+---------+----------|
| 9406321   | MGT123  | F1994    |
| 101202303 | CS305   | S1996    |
| 101202303 | CS315   | S1997    |
| 121232343 | EE101   | F1995    |
| 121232343 | EE101   | S1991    |
| 555666777 | Cs305   | F1995    |
| 783432188 | MGT123  | F1997    |
| 900120450 | MAT123  | F1997    |
| 900120450 | MAT123  | S1996    |
+-----------+---------+----------+
9 rows in set (0.01 sec)

5.11. Get the ids of all the students who took at least two courses.

(a) Relational algebraic expression. As we stated in the lecture, we rename all the attributes, except the StudId, of the Transcript table then join it with the original to agree on the StudId item, thus get all the transcript records of all the students. Notice with the condition, all the students who took only one will be left out.

\[
p_{\text{StudId}}(\sigma_{\text{CrsCode} \neq \text{CrsCode2}}(\text{Transcript} \bowtie \text{Transcript}[\text{StudID}, \text{CrsCode2}, \text{Semester2}, \text{Grade2}]))
\]

(b) MySQL code;

Select distinct T1.StudId
From Transcript T1, Transcript T2
Where T1.CrsCode<>T2.CrsCode
And T1.StudId=T2.StudId

mysql> Select T1.StudId
    -> From Transcript T1, Transcript T2
    -> And T1.StudId=T2.StudId;

+-----------+
| StudID    |
+-----------+
| 23456789  |
| 123454321 |
| 123454321 |
| 987654321 |
| 123454321 |
| 123454321 |
| 23456789  |
| 111111111 |
| 111111111 |
| 666666666 |
| 666666666 |
| 111111111 |
| 111111111 |
| 123454321 |
| 123454321 |
| 666666666 |
| 666666666 |
| 111111111 |
| 111111111 |
| 666666666 |
| 666666666 |
| 111111111 |
| 111111111 |
| 666666666 |
| 666666666 |
| 987654321 |
+-----------+

22 rows in set (0.05 sec)

This just gets us too much duplicated information. Since we only want to know the id once per student, we add in the `distinct` word.

mysql> Select distinct T1.StudID
    -> From Transcript T1, Transcript T2
    -> And T1.StudId=T2.StudId;
Indeed, except the one with 111223344, every student took at least two courses.

The restrictive `distinct` is indeed very useful.

**Distinction:** *Get the ids of professors who has taught together with the courses they taught.*

```
Select T.ProfId, T.CrsCode From Teaching T;
```

```
mysql> Select T.ProfId, T.CrsCode From Teaching T;
+-----------+---------+
| ProfId    | CrsCode |
|-----------+---------+
| 9406321   | MGT123  |
| 101202303 | CS305   |
| 101202303 | CS315   |
| 121232343 | EE101   |
| 121232343 | EE101   |
| 555666777 | Cs305   |
| 783432188 | MGT123  |
| 900120450 | MAT123  |
| 900120450 | MAT123  |
+-----------+---------+
9 rows in set (0.00 sec)
```

We certainly only need the following:

```
mysql> Select distinct T.ProfId, T.CrsCode From Teaching T;
+-----------+---------+
| ProfId    | CrsCode |
|-----------+---------+
| 9406321   | MGT123  |
| 101202303 | CS305   |
+-----------+---------+
```

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We can give more descriptive names for the resulting attributes.

**Renaming:** *Get the names of all the professors in the EE department.*

```
Select P.Name As Professor From Professor P Where DeptID='EE'
```

```
mysql> Select P.Name As Professor From Professor P Where DeptID='EE';
+-------------+
| Professor   |
+-------------+
| David Jones |
+-------------+
1 row in set (0.03 sec)
```

**Negation:** *Get the names of all the professors who don’t work in the EE department.*

```
Select P.Name As Professor From Professor P Where Not (DeptID = 'EE')
```

```
mysql> Select P.Name As Professor From Professor P Where Not (DeptID = 'EE')
-> ;
+-------------+
| Professor   |
+-------------+
| Jacob Taylor|
| John Smyth   |
| Mary Doe     |
| Adrian Jones |
| Qi Chen      |
| Ann White    |
+-------------+
6 rows in set (0.00 sec)
```

**Labwork 3.1:** For each of the following queries, you have to send in the query itself, its RA expression, the MySQL query, together with the results. The following queries are based on the *Supplier* database that you have created in Labwork 2:
1. Get all the parts stored in Rome.

2. Get all the suppliers who are based in London.

3. Get the color and city values of those parts that are not stored in Paris and with a
   weight of at least 10 tons (Oops, grams).

4. Get supplier names for suppliers who supply part P2.

5. Get supplier names for suppliers who supply at least one red part.

3.2 Set operations

It seems that, at least in MySQL version 5.7, only the **Union** operation is supported, neither
**Intersect** nor **Except** is.

5.15. *Get the names of all the professors in the CS department or in the EE department.*

(a) Relational algebraic expression.

\[ \pi_{\text{Name}}(\sigma_{\text{DeptId}='\text{CS}'}(\text{Professor})) \cup \pi_{\text{Name}}(\sigma_{\text{DeptId}='\text{EE}'}(\text{Professor})) \]

(b) MySQL code;

```sql
(Select P.Name From Professor P Where DeptID='CS')
Union (Select P.Name From Professor P Where DeptID='EE')
```

mysql> (Select P.Name From Professor P Where P.DeptID='CS') Union (Select P.Name -> From Professor P Where P.DeptID='EE');

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Smyth</td>
</tr>
<tr>
<td>Mary Doe</td>
</tr>
<tr>
<td>David Jones</td>
</tr>
</tbody>
</table>

3 rows in set (0.00 sec)

(c) Another form in MySQL (5.16).

```sql
Select P.Name From Professor P Where P.DeptID='CS' or P.DeptID='EE';
```
mysql> Select P.Name From Professor P Where P.DeptID='CS' or P.DeptId='EE';
+-------------+
| Name        |
+-------------+
| John Smyth  |
| David Jones |
| Mary Doe    |
+-------------+
3 rows in set (0.00 sec)

The word like can be used to match patterns.

5.17: *Get those who taught a CS course.*

mysql> Select Distinct P.Name From Professor P, Teaching T Where (P.Id=T.ProfId And T.CrsCode Like 'CS%') OR (P.DeptId='CS');

+------------+
| Name       |
+------------+
| John Smyth |
| Mary Doe   |
+------------+
2 rows in set (0.00 sec)

5.20: *Get those took both 'CS305' and 'CS315'*

(a) SQL code.

```
Select distinct S.Name From Student S,Transcript T1,Transcript T2
Where S.Id=T1.StudId And T1.CrsCode='CS305'
And S.Id=T2.StudId And T2.CrsCode='CS315';
```

(b) MySQL code and the result:

```
mysql> Select distinct S.Name From Student S,Transcript T1,Transcript T2
-> Where S.Id=T1.StudId And T1.CrsCode='CS305'
-> And S.Id=T2.StudId And T2.CrsCode='CS315';
+----------+
| Name     |
+----------+
| Joe Blow |
+----------+
1 row in set (0.00 sec)
Indeed, the following result shows that Joe Blow with the id being 123454321 is the only one who has taken both courses.

```sql
mysql> select * from transcript;
+----------------+---------+----------+-------+
<table>
<thead>
<tr>
<th>StudId</th>
<th>CrsCode</th>
<th>Semester</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>23456789</td>
<td>CS305</td>
<td>S1996</td>
<td>A</td>
</tr>
<tr>
<td>23456789</td>
<td>EE101</td>
<td>F1995</td>
<td>B</td>
</tr>
<tr>
<td>111111111</td>
<td>EE101</td>
<td>F1997</td>
<td>A</td>
</tr>
<tr>
<td>111111111</td>
<td>MAt123</td>
<td>F1997</td>
<td>B</td>
</tr>
<tr>
<td>111111111</td>
<td>MGT123</td>
<td>F1997</td>
<td>B</td>
</tr>
<tr>
<td>123454321</td>
<td>CS305</td>
<td>S1996</td>
<td>A</td>
</tr>
<tr>
<td>123454321</td>
<td>CS315</td>
<td>F1997</td>
<td>A</td>
</tr>
<tr>
<td>123454321</td>
<td>MAT123</td>
<td>S1996</td>
<td>C</td>
</tr>
<tr>
<td>666666666</td>
<td>EE101</td>
<td>S1991</td>
<td>B</td>
</tr>
<tr>
<td>666666666</td>
<td>MAT123</td>
<td>F1997</td>
<td>B</td>
</tr>
<tr>
<td>666666666</td>
<td>MGT123</td>
<td>F1994</td>
<td>A</td>
</tr>
<tr>
<td>987654321</td>
<td>CS305</td>
<td>F1995</td>
<td>C</td>
</tr>
<tr>
<td>987654321</td>
<td>MGT123</td>
<td>F1994</td>
<td>B</td>
</tr>
</tbody>
</table>
+----------------+---------+----------+-------+
13 rows in set (0.00 sec)
```

5.22: Get those professors who work either in the Computer Science department or in the Electrical Engineering department.

(a) Relational algebraic expression.

\[
\pi_{Name}(\sigma_{DeptId \in \{\text{'CS'\text{'}, 'EE'\text{'}\}}(Professor))
\]

(b) SQL code.

```
Select P.Name From Professor P
Where P.DeptId In ('CS', 'EE');
```

(c) MySQL code and the result:

```sql
mysql> SELECT P.Name From professor P
    
    -> where P.DeptId in ('CS', 'EE');

+---------------+
| Name          |
+---------------+
| John Smyth    |
| David Jones   |
| Mary Doe      |
```
Notice that MySQL v.5.7 does not support other set operators such as \texttt{Intersect} and \texttt{Except}. For example, neither of the following runs.

\begin{verbatim}
(SELECT StudId from Transcript where CrsCode='CS305') Intersect
(SELECT StudId from Transcript where CrsCode='CS315');

(SELECT StudId from Transcript where CrsCode='CS305')
Except
(SELECT StudId from Transcript where CrsCode='CS315');
\end{verbatim}

\textbf{Labwork 3.2:}

1. Check out the MySQL site to see if the current version supports all the three operations. If not, which are supported, and the correct syntax, with a simple example.

2. For each of the following queries, you have to send in the query itself, its RA expression, the MySQL query, together with the results. The following queries are based on the \textit{Supplier} database that you have created in Labwork 2:
   
   (a) Get parts that are either red or green.
   
   (b) Get supplier names for those who are located in either Rome or London.
   
   (c) Get supplier names for suppliers who supply both nuts and bolts.
   
   (d) Get supplier names for those who are located in either Rome or London and sell at least two kinds of parts.
   
   (e) Get supplier names for suppliers who do not supply red parts.

\textbf{3.3 Nested queries}

Now, we look at the more complicated situation, the nested queries. SQL Code is indeed achievable, since it is computationally complete. On the other hand, its implementation, such as MySQL v. 5.7, does not support all the structures, e.g., it does not support the quantifiers.

\textbf{To kick off:} Get all professor who taught in F1994.

(a) SQL code:
Select P.Name From Professor P
Where P.Id in
  #A nested subquery
    (Select T.ProfId From Teaching T
     Where T.Semester='F1994')

(b) MySQL code and its result

mysql> Select P.Name From Professor P
   -> Where P.Id in
   -> #A nested subquery
   -> (Select T.ProfId From Teaching T
   -> Where T.Semester='F1994');

+--------------+
| Name         |
+--------------+
| Jacob Taylor |
+--------------+
1 row in set (0.01 sec)

(c) This is confirmed by doing the following:

mysql> select * from Teaching;

+-----------+---------+----------+
| ProfId    | CrsCode | Semester |
+-----------+---------+----------+
| 9406321   | MGT123  | F1994    |
| 101202303 | CS305   | S1996    |
| 101202303 | CS315   | S1997    |
| 121232343 | EE101   | F1995    |
| 121232343 | EE101   | S1991    |
| 555666777 | Cs305   | F1995    |
| 783432188 | MGT123  | F1997    |
| 900120450 | MAT123  | F1997    |
| 900120450 | MAT123  | S1996    |
+-----------+---------+----------+
9 rows in set (0.00 sec)

5.23: Get all students who did not take any course.

(a) SQL code:

Select S.Name From Student S
Where S.Id Not in
  #A nested subquery
    (Select T.StudId From Transcript T);
5.25: Get all students and the courses that they took with a professor in F1994.

(a) SQL code:

```
Select distinct R.StudId, P.Id, R.CrsCode From Transcript R, Professor P
Where R.CrsCode in
    #courses taught by P.Id in F2004
    (Select T1.CrsCode From Teaching T1
     Where T1.ProfId=P.Id And T1.Semester='F1994');
```

(b) MySQL code and its result

```
mysql> Select distinct R.StudId, P.Id, R.CrsCode From Transcript R, Professor P
    -> Where R.CrsCode in
    -> #courses taught by P.Id in F1994
    -> (Select T1.CrsCode From Teaching T1
    -> Where T1.ProfId=P.Id And T1.Semester='F1994');
```

```
+-----------+---------+---------+
| StudId    | Id      | CrsCode |
|-----------+---------+---------|
| 111111111 | 9406321 | MGT123  |
| 666666666 | 9406321 | MGT123  |
| 987654321 | 9406321 | MGT123  |
+-----------+---------+---------+
3 rows in set (0.02 sec)
```

We sometimes want to use the Exists quantifier.

5.26: Get all students who never took a computer science course.

(a) SQL code:
Select S.Id From Student S
Where Not Exists
#there exists no CS courses that S.Id has taken
(Select T.CrsCode From Transcript T
 Where T.StudId=S.Id And T.CrsCode Like 'CS%');

(b) MySQL code and its result

mysql> Select S.Id From Student S
    -> Where Not Exists
    -> #there exists no CS courses that S.Id has taken
    -> (Select T.CrsCode From Transcript T
    -> Where T.StudId=S.Id And T.CrsCode Like 'CS%');

+-----------+
| Id         |
+-----------+
| 111111111 |
| 111223344 |
| 666666666 |
+-----------+
3 rows in set (0.00 sec)

Wrap up: Get all students who were taught by all the Computer Science professors.

This is a fairly complicated example, and it will be as far as we will go. For derivation details, please check out the lecture notes.

(a) MySQL code and its result

mysql> Select Name From Student
    -> Where Id Not In ( 
    -> Select Distinct S.Id
    -> From Student S, 
    -> #All CS Professors
    -> (Select P.Id From Professor P
    -> Where P.DeptId='CS') As C 
    -> Where C.Id Not In 
    -> #Professors who has taught S 
    -> (Select T.ProfId
    -> From Teaching T, Transcript R 
    -> Where T.CrsCode=R.CrsCode And 
    -> T.Semester=R.Semester And 
    -> S.Id=R.StudId));

+----------+
| Name      |
+----------+
Note: The current version of MySQL does not support the All quantifier. For example, the following does not run.

```
Select S.Id From Student S
Where
 For All (Select C.CrsCode From Course C
 Where C.CrsCode Like 'CS%')
 (CrsCode in
 (Select R.CrsCode From Transcript R
 Where R.StudId=S.Id));
```

Labwork 3.3:

1. Check out the current MySQL version to see if it supports either All and/or Exist quantifier. If it does, give the syntax and an example.

2. For each of the following queries, you have to send in the query itself, its RA expression, the MySQL query, together with the results. The following queries are based on the Supplier database that you have created in Labwork 2:

   (a) Get all the details of those parts supplied by someone located in London.
   (b) Get supplier names for suppliers who supply at least one red part.
   (c) Get supplier names for those who supply nuts.
   (d) Find supplier names who supply all the parts. (Hint: This is entirely parallel to the example as we went through in the class, i.e., the above Wrap up example. Check out that part in the teaching notes.)

3.4 Aggregation

We now turn to the aggregation stuff with a few simple examples.

Kick off: Find out the average age of student body.

(a) Change the tables a bit: Notice that we need to add in an attribute Age: INT to both the Student and the Professor table; and a GPA: Float to Student; which can be done as follows:
mysql> alter table Professor add Age Int Not Null;
Query OK, 7 rows affected (0.34 sec)
Records: 7  Duplicates: 0  Warnings: 0

mysql> desc professor;
+--------+----------+------+-----+---------+-------+
| Field | Type | Null | Key | Default | Extra |
+--------+----------+------+-----+---------+-------+
| Id | int(11) | | PRI | 0 | |
| Name | char(20) | | | | |
| DeptId | char(4) | YES | | NULL | |
| Age | int(11) | | | 0 | |
+--------+----------+------+-----+---------+-------+
4 rows in set (0.02 sec)

We then need to add in the missing data. We can use the Update to do it. But, the far easier way is to use the GUI interface.

mysql> select * from Professor;
+-----------+--------------+--------+-----+
| Id | Name | DeptId | Age |
+-----------+--------------+--------+-----+
| 9406321 | Jacob Taylor | MGT | 45 |
| 101202303 | John Smyth | CS | 32 |
| 121232343 | David Jones | EE | 56 |
| 555666777 | Mary Doe | CS | 67 |
| 783432188 | Adrian Jones | MGT | 55 |
| 864297351 | Qi Chen | MAt | 34 |
| 900120450 | White | MAT | 43 |
+-----------+--------------+--------+-----+
7 rows in set (0.00 sec)

mysql> select * from Student;
+-----------+---------------+----------------+-----------+-----+------+
| Id | Name | Address | Status | Age | GPA |
+-----------+---------------+----------------+-----------+-----+------+
| 23456789 | Homer Simpson | Fox 5 Tv | senior | 21 | 3.3 |
| 111111111 | Jane Doe | 123 Main St. | freshman | 19 | 3.4 |
| 111223344 | Mary Smith | 1 Lake St. | freshman | 21 | 3.5 |
| 123454321 | Joe Blow | 6 Yard Ct. | junior | 20 | 3.2 |
| 666666666 | Jesoph Public | 666 Hollow Rd. | sophomore | 21 | 3.3 |
| 987654321 | Bart Simpson | Fox 5 Tv | senior | 22 | 3.6 |
+-----------+---------------+----------------+-----------+-----+------+
Kick off: Find out the minimum age among professors in the Management Department.

(a) SQL code:

```
Select Min(P.Age) From Professor P Where P.DeptId='MGT';
```

(b) MySQL code and the result:

```
mysql> Select Min(P.Age) From Professor P
    -> Where P.DeptId='MGT';
```

```
+------------+
| Min(P.Age) |
+------------+
|    45      |
+------------+
1 row in set (0.00 sec)
```

Kick off: Find out the youngest professor(s) in the Management Department.

(a) SQL Code:

```
Select P.Name,P.Age From Professor P
Where P.DeptId='MGT' And
P.Age=(Select Min(P1.Age)
    From Professor P1
    Where P1.DeptId='MGT');
```

(b) MySQL Code and the result:
mysql> Select P.Name, P.Age From Professor P
      -> Where P.DeptId='MGT' And
      -> P.Age=(Select Min(P1.Age)
      -> From Professor P1
      -> Where P1.DeptId='MGT');

+--------------+-----+
| Name         | Age |
+--------------+-----+
| Jacob Taylor | 45  |
+--------------+-----+
1 row in set (0.00 sec)

The following is a bit different from Query 5.31.

5.31. Find out the student(s) with the highest GPA.

(a) SQL Code:

```
Select S.Name, S.Id From Student S
Where S.GPA >= (Select Max(S1.GPA)
From Student S1);
```

(b) MySQL code and the result:

```
mysql> Select S.Name, S.Id From Student S
      -> Where S.GPA >= (Select Max(S1.GPA)
      -> From Student S1);

+--------------+-----------+
| Name         | Id        |
+--------------+-----------+
| Bart Simpson | 987654321 |
+--------------+-----------+
1 row in set (0.00 sec)
```

5.32(a). Get the number of professors in the Management Department.

(a) SQL code:

```
select count(P.Name) From Professor P Where P.DeptId='MGT';
```

(b) MySQL code and the result.
5.32(b). *Get the number of different names of professors in the Management Department.*

(a) SQL code:

```sql
Select count(distinct P.Name) From Professor P Where P.DeptId='MGT';
```

(b) MySQL code and the result.

```sql
mysql> select count(distinct P.Name) From Professor P Where P.DeptId='MGT';
+--------------------+
| count(distinct P.Name) |
+--------------------+
| 2                  |
+--------------------+
1 row in set (0.03 sec)
```

In this case, the results are the same, because of the following data. This does not need to be the same in general.

```sql
mysql> select P.Name from Professor P where P.DeptId='MGT';
+------------+
| Name       |
+------------+
| Jacob Taylor |
| Adrian Jones |
+------------+
2 rows in set (0.00 sec)
```

**Groups:** *Find out the number of courses, the average grade, that every student has taken.*

(a) SQL code:

```sql
Select T.StudId, Count(*) As NumCrs,
Avg(T.Grade) As CrsAvg
From Transcript T
Group By T.StudId;
```

(b) MySQL code and the result.

```sql
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```
mysql> Select T.StudId, Count(*) As NumCrs,  
    -> Avg(T.Grade) As CrsAvg  
    -> From Transcript T  
    -> Group By T.StudId;

+-----------+--------+--------+
| StudId    | NumCrs | CrsAvg |
+-----------+--------+--------+
| 23456789  | 2      | 0      |
| 111111111 | 3      | 0      |
| 123454321 | 3      | 0      |
| 666666666 | 3      | 0      |
| 987654321  | 2      | 0      |
+-----------+--------+--------+
5 rows in set (0.00 sec)

Apparently, when applied to characters, Avg returns 0.

**Groups**: Find out the number of professors and their average age in each department.

(a) SQL code:

```
Select P.DeptId, count(P.Name) As DeptSize,  
    Avg(P.Age) As AvgSize  
From Professor P  
Group By P.DeptId;
```

(b) MySQL code and the result:

```
mysql> Select P.DeptId, count(P.Name) As DeptSize,  
    -> Avg(P.Age) As AvgSize  
    -> From Professor P  
    -> Group By P.DeptId;
```

```
+--------+----------+---------+
| DeptId | DeptSize | AvgSize |
+--------+----------+---------+
| CS     | 2        | 49.5000 |
| EE     | 1        | 56.0000 |
| MAt    | 2        | 38.5000 |
| MGT    | 2        | 50.0000 |
+--------+----------+---------+
4 rows in set (0.00 sec)
```

**Order By**: Find out the number of professors and their average age in each department, ordered by their department name.
(a) SQL code:

```
Select P.DeptId As DeptName, count(P.Name) As DeptSize,
     Avg(P.Age) As AvgSize
From Professor P
Group By P.DeptId
Order By DeptName;
```

(b) MySQL code and the result:

```
mysql> Select P.DeptId As DeptName, count(P.Name) As DeptSize,
    -> Avg(P.Age) As AvgSize
    -> From Professor P
    -> Group By P.DeptId
    -> Order By DeptName;

+----------+----------+---------+
<table>
<thead>
<tr>
<th>DeptName</th>
<th>DeptSize</th>
<th>AvgSize</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS</td>
<td>2</td>
<td>49.5000</td>
</tr>
<tr>
<td>EE</td>
<td>1</td>
<td>56.0000</td>
</tr>
<tr>
<td>MAt</td>
<td>2</td>
<td>38.5000</td>
</tr>
<tr>
<td>MGT</td>
<td>2</td>
<td>50.0000</td>
</tr>
</tbody>
</table>
+----------+----------+---------+
4 rows in set (0.00 sec)
```

**Labwork 3.4:** For each of the following queries, you have to send in the MySQL query, together with the results. The following queries are based on the Supplier database that you have created in Labwork 2 or the Registration database, as extended at the beginning of this sub-section:

1. Get total number of parts supplied by supplier S1.
2. Get the total quantity of part P1 supplied by S1.
3. Get supplier names for those with status less than the current maximum status in the Supplier table.
4. Find out the youngest student.
5. Find the average age of students who received an A for some course.
4 On the views

As we mentioned in the lecture [§5.2.8] [1], the view concept provides an external, customized, view of a database. View as a technique is particularly useful when we want to decompose a rather complicated task into a bunch of smaller and/or simpler ones. MySQL does support this feature since ver. 5.0.

For example, if we want to insert a bunch of tuples into a table easyClass, which contains classes that are so easy that more than 20% of the students got A.

The easyClass table can be created as follows:

Create table easyClass (  
CrsCode Char(6) Not Null,  
Semester Char(6) Not Null,  
AceRate Float,  
Primary key (CrsCode, Semester),  
Foreign key (CrsCode) references Course(CrsCode),  
Constraint grade_condition Check (Grade in ('A','B','C','D','F')));

mysql> desc easyClass;
+----------+---------+------+-----+---------+-------+
| Field | Type   | Null | Key | Default | Extra |
|--------+--------+-------+-----+---------+-------|
| CrsCode | char(6) | NO    | PRI | NULL    |       |
| Semester | char(6) | NO    | PRI | NULL    |       |
| AceRate | float  | YES   |     | NULL    |       |
+----------+--------+-------+-----+---------+-------+
3 rows in set (0.01 sec)

It will be pretty boring to enter all the tuples to this just created table. On the other hand, we have collected all the relevant information in the database, and we can automatically populate easyClass with the help of the view mechanism as follows:

We create a view to collect the number of students who aced a class for each class.

Create view ClassAce  
(CrsCode, Semester, Aced) As  
Select T.CrsCode, T.Semester, Count(*)  
From transcript T  
Where T.Grade='A'  
Group By T.CrsCode, T.Semester;

Although ClassAce is not a table, its structure can still be checked just like a table.
Similarly, we can create another view that collects the enrollment for each class.

Create view ClassEnrollment
(CrsCode, Semester, Enrolled) As
Select T.CrsCode, T.Semester, Count(*)
From transcript T
Group By T.CrsCode, T.Semester

Now, the table easyClass can be populated as follows:

Insert into easyClass(CrsCode, Semester, AceRate)
Select A.CrsCode, A.Semester, A.Aced/E.Enrolled
From ClassAce A, ClassEnrollment E
Where A.CrsCode=E.CrsCode
And A.Semester=E.Semester
And (A.Aced/E.Enrolled)>0.2;

The output is as follows:

mysql> select * from easyClass;

+---------+----------+---------+
<table>
<thead>
<tr>
<th>CrsCode</th>
<th>Semester</th>
<th>AceRate</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS305</td>
<td>S1996</td>
<td>1</td>
</tr>
</tbody>
</table>
To verify, we include the data from the original transcript: For example, everybody who took CS305 in S1996 got ‘A’; while only half of those taking MGT123 in F1994 got ‘A’; and no more than 20% of those taking, e.g., MAT123, got ‘A’, 0% to be exact.

```
mysql> select * from transcript;
+-----------+---------+----------+-------+
| StudId    | CrsCode | Semester | Grade |
|-----------+---------+----------+-------|
| 23456789  | CS305   | S1996    | A     |
| 23456789  | EE101   | F1995    | B     |
| 111111111 | EE101   | F1997    | A     |
| 111111111 | MAT123  | F1997    | B     |
| 111111111 | MGT123  | F1997    | B     |
| 123454321 | CS305   | S1996    | A     |
| 123454321 | CS15    | F1997    | A     |
| 123454321 | MAT123  | S1996    | C     |
| 666666666 | EE101   | S1991    | B     |
| 666666666 | MAT123  | F1997    | B     |
| 666666666 | MGT123  | F1994    | A     |
| 987654321 | CS305   | F1995    | C     |
| 987654321 | MGT123  | F1994    | B     |
+-----------+---------+----------+-------+
```

13 rows in set (0.00 sec)

It would be tough without using views.

**Labwork 4:**

1. Test out the above scripts with `MySQL` yourself. Then, modify the given scripts to come up with a view `hardClass`, that reports those classes in which more than 10% failed. Send in the `MySQL` code together with the original data as contained in the `Transcript` table, and the data obtained via the `hardClass` view.

2. Complete 5.17 (e, f) in the textbook. For both assignments, send in the `MySQL` code together with the original data as contained in the `Professor` table, and the data obtained via the view ².

²You need to add in a `Salary` attribute into the `Professor` table, and fill in some values there.
(e) Find the professors whose salaries are at least 10% higher than the average salary of all professors.

(f) Find all professors whose salaries are at least 10% higher than the average salary of all professors in their departments. (Hint: Use views, as in (5.39).)

3. Complete exercise 5.27 in the textbook, as follows:

“Using the relations Teaching and Professor, create a view of Transcript containing only rows corresponding to classes taught by John Smyth.”

and utilize this just created view to generate a table JohnSFavorite, which collects the students that have got a ‘B’ or better from John Smyth, the courses they took with Professor Smyty, together with the respective grade.

Wrap up: Find out the youngest straight A students and their age.

5 MySQL and PhP

MySQL, as a (partial) implementation of the SQL specification, is a very good language for defining the structure of the database, and generating ad hoc queries. However, to build meaningful applications, the power of a full-fledged high-level programming language, such as Java, C++, or PhP, is needed.

Moreover, in today’s WEB age, lots of database programming are done over the Internet, using WEB, i.e., HTML, as a visual media. We will discuss, or have discussed, depending on when you take on this part, more fully in Part (I) of the lab notes, A Gentler Introduction to PhP and Its Application in Database Programming, about the connection between PhP and MySQL in database programming.

In this section, we merely present a PhP script, sendGeneralQuery.html, with which you can test out any query you have designed that deals with the student registration database.

<Html>
<!--This file, sendGeneralQuery.html, is to send a query, which will be picked up and processed by showGeneralQueryResult.php -->
</Head>
</Html>

3By a “straight A” student, we mean someone who got ‘A’ in all the courses that she has taken. There might be several of them, thus the plural “students”, all sharing the same age, thus the singular “age”.

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<Table Border=0 cellPadding=10 Width=100%>
  <Tr>
    <!--The following cell specifies the left cushion edge-->
    <Td BGColor="F0F8FF" Align=Center VAlign=top Width=17%></Td>
    <!--The following gives the right entry form part, completely white-->
    <Td BGColor="FFFFFF" Align=Left VAlign=Top Width=83%>
      <H1>Query submission form;</H1>
      <p>Enter your query and we will send you back the result.</p>
      <!--Data will be transmitted via the post method, and will be handled by the-->
      <!-- specific file. We will talk in detail about such methods, later -->
      <!--First input box, with a name "query", thus earmarked with the name -->
      <!-- $_POST['query'] in the handler. The value will be filled in by the user -->
      <Input Type="text" Size=25 Name="query">
      <BR><BR>
      <!--The submit button, with the name being $_POST['submit'], -->
      <!--and the message shown being 'Submit'-->
      <!--When clicked, the filled query is sent over -->
      <Input Type="submit" Name="submit" Value="Submit">
    </Td>
  </Tr>
</Table>

The following is the file showGeneralQueryResult.php, which handles the query sent over by the previous file.

<?php

    //Include all the functions needed to print out the content of a single table
    include("displayQueryResult.inc");
<?php

//This is where the private information is kept.

This script includes the **displayQueryResult.inc**, which, besides setting up the needed connection to the database, also defines the needed procedure to display the result of the query. This file is also needed for some of the scripts as mentioned in the *PhP* notes.

<?php

//This is where the private information is kept.
include("home/phpbook/phpbook-vars.inc");

// Set up all the other needed information
$global_dbh=mysql_connect($hostname, $user, $password)
or die("Could not connect to database");

// Set the name of the database you want to work with
$db="registration";

// Select the database to work with
mysql_select_db($db, $global_dbh)
or die("Could not select database");

// This the function to display the result of the query
function display_db_query($query_string, $connection, $header_bool, $table_params){

    // perform the database query
    $result_id=mysql_query($query_string, $connection)
or die("display_db_query: ". mysql_error());

    // find out the number of columns in result
    $column_count=mysql_num_fields($result_id)
or die("display_db_query: ". mysql_error());

    // Table form include optional HTML arguments passed into function
    print("<Table $table_params >\n");

    // Optionally print a bold header at top of table
    if($header_bool){
        print("<Tr>\n");
        for ($column_num=0; $column_num< $column_count; $column_num++){
            $field_name=mysql_field_name($result_id, $column_num);
            print("<Th>$field_name</Th>\n");
        }
        print("</Tr>\n");
    }

    // print out the body of the table, using a cursor
    while($row= mysql_fetch_row($result_id)){
        print("<Tr Align=left Valign=top>\n");
        for ($column_num=0; $column_num< $column_count; $column_num++)
            print("<Td>$row[$column_num]</Td>\n");
        print("</Tr>\n");
    }
}
This file itself also includes another one, home/phpbook/phpbook-vars.inc, storing user information, e.g.

```php
<?php
    // Critical data to make the connection
    // You should not change the following line
    $hostname='localhost';
    // Change the following to your user name. The following assumes that your user name
    // is "johnDoe".
    $user='johnDoe';
    // Change the following to your password. The following assumes that your password is
    // "Colt45".
    $password='Colt45';
?>
```

To test this program in a *php enabled* server such as turing, and assume your user name is *j_doe*, just place all the files in a folder, e.g., PhPFiles, under the Home folder of turing. Notice that the phpbook-vars.inc is placed in a folder home/phpbook under PhPFiles.

You can then run the program by *Opening* the following in IE:

```
http://turing.plymouth.edu/~j_doe/PhPFiles/sendGeneralQuery.html
```

**Note:**

1. Check out the following:
   ```
   http://turing.plymouth.edu/~zshen/PhPFiles/sendGeneralQuery.html
   ```

2. You can use the same file structure to set up the files home/phpbook/phpbook-vars.inc, and displayQueryResult.inc.

3. You can use the `display_db_query` function in your script once you understand its syntax, as well as its content.

4. This simple interface contains just one button, accepting a dynamic SQL query, which could be part of your interface of your project.

**Labwork 5:**

1. Set up the appropriate file structure.
2. Put all the files, four of them, in the right place.

3. Test out the related scripts.

4. Use this script to test out the SQL related homework you should have done for the *registration* database.

5. Notice this script can only check out queries for the *registration* database. Make the necessary changes in the script so that you can use this script to test out the queries that you have written down for your group’s project.

References
