一、在 openGauss 中创建 MYDB 数据库，并在 MYDB 中创建学生、课程、选课三个表。

各表包含属性如下：

S549（S#，SNAME，SEX，BDATE，HEIGHT，DORM）

C549（C#，CNAME，PERIOD，CREDIT，TEACHER）

SC549（S#，C#，GRADE）其中 S#、C#均为外键

本次实验在本地主机上安装 openEuler 和 opengauss，通过 vscode 实现 ssh 远程连接

设置密码

```
openGauss=# CREATE USER joe WITH PASSWORD "Aa@2240791308";
CREATE ROLE
openGauss=# CREATE DATABASE my-db  OWNER joe;
ERROR:  syntax error at or near "-"
LINE 1: CREATE DATABASE my-db  OWNER joe;
                           ^
openGauss=# CREATE DATABASE my_db  OWNER joe;
CREATE DATABASE
```

```
[opengauss@localhost ~]$ gsql -d my_db  -U joe
Password for user joe:
gsql ((openGauss 2.1.0 build ) compiled at 2024-05-25 10:08:17 commit 0 last mr  )
Non-SSL connection (SSL connection is recommended when requiring high-security)
Type "help" for help.

my_db=>
```

```
CREATE TABLE IF NOT EXISTS S549
(Sno Integer PRIMARY KEY, Sname VARCHAR(32), Sex Char(4), BDATE Date, Height
Number, Dorm VARCHAR(32));
CREATE TABLE IF NOT EXISTS C549
(Cno VARChar(16) PRIMARY KEY, Cname VARCHAR(32), Period Integer, Credit
Float, Teacher VARCHAR(32));
CREATE TABLE IF NOT EXISTS SC549
(Sno Integer, Cno VARChar(16), Grade Number,
PRIMARY KEY(Sno, Cno), Foreign Key(Sno) references S549(Sno), Foreign
Key(Cno) references C549(Cno))
```

```
my_db=> CREATE TABLE IF NOT EXISTS S549
(Sno Integer PRIMAmy_db-> RY KEY, Sname VARCHAR(32), Sex Char(4), BDATE Date, Height
Number, Dorm VARCHAR(32));
my_db(> NOTICE:  CREATE TABLE / PRIMARY KEY will create implicit index "s549_pkey" for table "
s549"
CREATE TABLE
my_db=> CREATE TABLE IF NOT EXISTS S549
(Sno Integer PRIMAmy_db-> RY KEY, Sname VARCHAR(32), Sex Char(4), BDATE Date, Height
Number, Dorm VARCHAR(32));
CREATE TABLE Imy_db(> NOTICE:  relation "s549" already exists, skipping
CREATE TABLE
my_db=> F NOT EXISTS C549
(Cno VARChar(16) PRIMARY KEY, Cnmy_db-> ame VARCHAR(32), Period Integer, Credit
Float, Teamy_db(> cher VARCHAR(32));
CREATE TABLE IF NOT EXISTS SC549
(Sno Integer, Cno VARChar(16), Grade Number,
PRIMARY KEY(Sno, Cno), Foreign Key(Sno) references S5NOTICE:  CREATE TABLE / PRIMARY KEY will
create implicit index "c549_pkey" for table "c549"
49(Sno), Foreign
Key(Cno) references C549(Cno));
CREATE TABLE
my_db=> my_db-> my_db(> my_db(> NOTICE:  CREATE TABLE / PRIMARY KEY will create implicit index
 "sc549_pkey" for table "sc549"
CREATE TABLE
```

```
my_db=> \d+
                                    List of relations
 Schema | Name  | Type  | Owner |    Size    |            Storage             | Description
--------+-------+-------+-------+------------+--------------------------------+-------------
 public | c549  | table | joe   | 0 bytes    | {orientation=row,compression=no} |
 public | s549  | table | joe   | 8192 bytes | {orientation=row,compression=no} |
 public | sc549 | table | joe   | 8192 bytes | {orientation=row,compression=no} |
(3 rows)
```

```
my_db=> \d+ S549
                                Table "public.s549"
 Column |             Type              | Modifiers | Storage  | Stats target | Description
--------+-------------------------------+-----------+----------+--------------+-------------
 sno    | integer                       | not null  | plain    |              |
 sname  | character varying(32)         |           | extended |              |
 sex    | character(4)                  |           | extended |              |
 bdate  | timestamp(0) without time zone |           | plain    |              |
 height | numeric                       |           | main     |              |
 dorm   | character varying(32)         |           | extended |              |
Indexes:
    "s549_pkey" PRIMARY KEY, btree (sno) TABLESPACE pg_default
Referenced by:
    TABLE "sc549" CONSTRAINT "sc549_sno_fkey" FOREIGN KEY (sno) REFERENCES s549(sno)
Has OIDs: no
Options: orientation=row, compression=no
```

```
my_db=> \d+ C549
                                Table "public.c549"
 Column  |         Type          | Modifiers | Storage  | Stats target | Description
---------+-----------------------+-----------+----------+--------------+-------------
 cno     | character varying(16) | not null  | extended |              |
 cname   | character varying(32) |           | extended |              |
 period  | integer               |           | plain    |              |
 credit  | double precision      |           | plain    |              |
 teacher | character varying(32) |           | extended |              |
Indexes:
    "c549_pkey" PRIMARY KEY, btree (cno) TABLESPACE pg_default
Referenced by:
    TABLE "sc549" CONSTRAINT "sc549_cno_fkey" FOREIGN KEY (cno) REFERENCES c549(cno)
Has OIDs: no
Options: orientation=row, compression=no
```

```
my_db=> \d+ SC549
                               Table "public.sc549"
 Column |         Type          | Modifiers | Storage  | Stats target | Description
--------+-----------------------+-----------+----------+--------------+-------------
 sno    | integer               | not null  | plain    |              |
 cno    | character varying(16) | not null  | extended |              |
 grade  | numeric               |           | main     |              |
Indexes:
    "sc549_pkey" PRIMARY KEY, btree (sno, cno) TABLESPACE pg_default
Foreign-key constraints:
    "sc549_cno_fkey" FOREIGN KEY (cno) REFERENCES c549(cno)
    "sc549_sno_fkey" FOREIGN KEY (sno) REFERENCES s549(sno)
Has OIDs: no
Options: orientation=row, compression=no
```

二、将数据加入相应的表中。

```
INSERT INTO S549 VALUES
(01032010,'王涛','男','2003-4-5',1.72,'东 6 舍 221'),
(01032023,'孙文','男','2004-6-10',1.80,'东 6 舍 221'),
(01032001,'张晓梅','女','2004-11-17',1.58,'东 1 舍 312'),
(01032005,'刘静','女','2003-1-10',1.63,'东 1 舍 312'),
(01032112,'董蔚','男','2003-2-20',1.71,'东 6 舍 221'),
(03031011,'王倩','女','2004-12-20',1.66,'东 2 舍 104'),
(03031014,'赵思扬','男','2002-6-6',1.85,'东 18 舍 421'),
(03031051,'周剑','男','2002-5-8',1.68,'东 18 舍 422'),
(03031009,'田菲','女','2003-8-11',1.60,'东 2 舍 104'),
(03031033,'蔡明明','男','2003-3-12',1.75,'东 18 舍 423'),
(03031056,'曹子衿','女','2004-12-15',1.65,'东 2 舍 305');
```

```
my_db=> INSERT INTO S549 VALUES
(01032010,'王涛','男','2003-4my_db-> -5',1.72,'东6舍221'),
(01032023,'孙文','男','2004-6-10'my_db-> ,1.80,'东6舍221'),
(01032001,'张晓梅','女','2004-11-17',my_db-> 1.58,'东1舍312'),
(01032005,'刘静','女','2003-1-10',1.6my_db-> 3,'东1舍312'),
(01032112,'董蔚','男','2003-2-20',1.71,'my_db-> 东6舍221'),
(03031011,'王倩','女','2004-12-20',1.66,'东my_db-> 2舍104'),
(03031014,'赵思扬','男','2002-6-6',1.85,'东18舍my_db-> 421'),
(03031051,'周剑','男','2002-5-8',1.68,'东18舍422my_db-> '),
(03031009,'田菲','女','2003-8-11',1.60,'东2舍104'),my_db->
(03031033,'蔡明明','男','2003-3-12',1.75,'东18舍423'),
my_db-> my_db-> (03031056,'曹子衿','女','2004-12-15',1.65,'东2舍305');
INSERT 0 11
my_db=> SELECR * FROM S549
my_db-> ;
ERROR:  syntax error at or near "SELECR"
LINE 1: SELECR * FROM S549
        ^
my_db=> SELECT * FROM S549;
   sno   | sname  | sex |        bdate        | height |   dorm
---------+--------+-----+---------------------+--------+----------
 1032010 | 王涛   | 男  | 2003-04-05 00:00:00 |   1.72 | 东6舍221
 1032023 | 孙文   | 男  | 2004-06-10 00:00:00 |   1.80 | 东6舍221
 1032001 | 张晓梅 | 女  | 2004-11-17 00:00:00 |   1.58 | 东1舍312
 1032005 | 刘静   | 女  | 2003-01-10 00:00:00 |   1.63 | 东1舍312
 1032112 | 董蔚   | 男  | 2003-02-20 00:00:00 |   1.71 | 东6舍221
 3031011 | 王倩   | 女  | 2004-12-20 00:00:00 |   1.66 | 东2舍104
 3031014 | 赵思扬 | 男  | 2002-06-06 00:00:00 |   1.85 | 东18舍421
 3031051 | 周剑   | 男  | 2002-05-08 00:00:00 |   1.68 | 东18舍422
 3031009 | 田菲   | 女  | 2003-08-11 00:00:00 |   1.60 | 东2舍104
 3031033 | 蔡明明 | 男  | 2003-03-12 00:00:00 |   1.75 | 东18舍423
 3031056 | 曹子衿 | 女  | 2004-12-15 00:00:00 |   1.65 | 东2舍305
(11 rows)
```

```
INSERT INTO C549 VALUES
('CS-01','数据结构',60,3,'张军'),
('CS-02','计算机组成原理',80,4,'王亚伟'),
('CS-04','人工智能',40,2,'李蕾'),
('CS-05','深度学习',40,2,'崔均'),
('EE-01','信号与系统',60,3,'张明'),
('EE-02','数字逻辑电路',100,5,'胡海东'),
('EE-03','光电子学与光子学',40,2,'石韬');
```

```
openGauss=# INSERT INTO C549 VALUES
openGauss-# ('CS-01','数据结构',60,3,'张军'),
openGauss-# ('CS-02','计算机组成原理',80,4,'王亚伟'),
openGauss-# ('CS-04','人工智能',40,2,'李蕾'),
openGauss-# ('CS-05','深度学习',40,2,'崔均'),
openGauss-# ('EE-01','信号与系统',60,3,'张明'),
openGauss-# ('EE-02','数字逻辑电路',100,5,'胡海东'),
openGauss-# ('EE-03','光电子学与光子学',40,2,'石韬');
INSERT 0 7
openGauss=# SELECT * FROM C549;
  cno   |       cname        | period | credit | teacher
--------+--------------------+--------+--------+---------
 CS-01  | 数据结构           |     60 |      3 | 张军
 CS-02  | 计算机组成原理     |     80 |      4 | 王亚伟
 CS-04  | 人工智能           |     40 |      2 | 李蕾
 CS-05  | 深度学习           |     40 |      2 | 崔均
 EE-01  | 信号与系统         |     60 |      3 | 张明
 EE-02  | 数字逻辑电路       |    100 |      5 | 胡海东
 EE-03  | 光电子学与光子学   |     40 |      2 | 石韬
(7 rows)
```

```
INSERT INTO SC549 VALUES
(01032010,'CS-01',82),
(01032010,'CS-02',91),
(01032010,'CS-04',83.5),
(01032001,'CS-01',77.5),
(01032001,'CS-02',85),
```

(01032001,'CS-04',83),

(01032005,'CS-01',62),

(01032005,'CS-02',77),

(01032005,'CS-04',82),

(01032023,'CS-01',55),

(01032023,'CS-02',81),

(01032023,'CS-04',76),

(01032112,'CS-01',88),

(01032112,'CS-02',91.5),

(01032112,'CS-04',86),

(01032112,'CS-05',NULL),

(03031033,'EE-01',93),

(03031033,'EE-02',89),

(03031009,'EE-01',88),

(03031009,'EE-02',78.5),

(03031011,'EE-01',91),

(03031011,'EE-02',86),

(03031051,'EE-01',78),

(03031051,'EE-02',58),

(03031014,'EE-01',79),

(03031014,'EE-02',71);

```
(03031014,'EE-02',71);
my_db-> INSERT 0 26
my_db=> SELECT * FROM SC549;
   sno    |  cno   | grade
---------+-------+-------
 1032010 | CS-01 |    82
 1032010 | CS-02 |    91
 1032010 | CS-04 |  83.5
 1032001 | CS-01 |  77.5
 1032001 | CS-02 |    85
 1032001 | CS-04 |    83
 1032005 | CS-01 |    62
 1032005 | CS-02 |    77
 1032005 | CS-04 |    82
 1032023 | CS-01 |    55
 1032023 | CS-02 |    81
 1032023 | CS-04 |    76
 1032112 | CS-01 |    88
 1032112 | CS-02 |  91.5
 1032112 | CS-04 |    86
 1032112 | CS-05 |
 3031033 | EE-01 |    93
 3031033 | EE-02 |    89
 3031009 | EE-01 |    88
 3031009 | EE-02 |  78.5
 3031011 | EE-01 |    91
 3031011 | EE-02 |    86
 3031051 | EE-01 |    78
 3031051 | EE-02 |    58
 3031014 | EE-01 |    79
 3031014 | EE-02 |    71
(26 rows)
```

三、完成以下操作，将相应 SQL 语句及其执行结果截屏保存，并写入实验报告中。

1．在上述基本表上完成以下查询：

(1) 查询电子工程系（EE）所开课程的课程编号、课程名称及学分数。

SELECT Cno, Cname FROM C549 WHERE Cno LIKE 'EE%';

```
my_db=> SELECT Cno, Cname FROM C549 WHERE Cno LIKE 'EE%';
  cno   |       cname
--------+--------------------
 EE-01  | 信号与系统
 EE-02  | 数字逻辑电路
 EE-03  | 光电子学与光子学
(3 rows)
```

(2) 查询未选修课程“CS-02”的女生学号及其已选各课程编号、成绩。

SQL 语句解释：先通过 SELECT 子查询获得选修课程“CS-02”的学生学号，

再使用 NOT IN 语句得到最终结果。

SELECT SC549.Sno, SC549.Cno, SC549.Grade

FROM SC549 ,S549

WHERE (SC549.Sno = S549.Sno) AND (S549.Sex = '女')AND S549.Sno NOT IN (SELECT

Sno FROM SC549 WHERE Cno = 'CS-02');

```
my_db=> SELECT SC549.Sno, SC549.Cno, SC549.Grade
my_db-> FROM SC549 ,S549
my_db-> WHERE (SC549.Sno = S549.Sno) AND (S549.Sex = '女')AND S549.Sno NOT IN
my_db-> (SELECT Sno FROM SC549 WHERE Cno = 'CS-02');
   sno    |  cno   | grade
---------+-------+-------
 3031011 | EE-01 |    91
 3031011 | EE-02 |    86
 3031009 | EE-01 |    88
 3031009 | EE-02 |  78.5
(4 rows)
```

(3) 查询 2002 年～2003 年出生学生的基本信息。

SQL 语句解释：使用 BETWEEN AND 语句确定出生日期范围。

SELECT * FROM S549 WHERE Bdate BETWEEN '2002-01-01' and '2003-12-31';

```
my_db=> SELECT * FROM S549 WHERE Bdate BETWEEN '2002-01-01' and '2003-12-31';
   sno    | sname  | sex |        bdate        | height |   dorm
---------+--------+-----+---------------------+--------+----------
 1032010 | 王涛   | 男  | 2003-04-05 00:00:00 |   1.72 | 东6舍221
 1032005 | 刘静   | 女  | 2003-01-10 00:00:00 |   1.63 | 东1舍312
 1032112 | 董蔚   | 男  | 2003-02-20 00:00:00 |   1.71 | 东6舍221
 3031014 | 赵思扬 | 男  | 2002-06-06 00:00:00 |   1.85 | 东18舍421
 3031051 | 周剑   | 男  | 2002-05-08 00:00:00 |   1.68 | 东18舍422
 3031009 | 田菲   | 女  | 2003-08-11 00:00:00 |   1.60 | 东2舍104
 3031033 | 蔡明明 | 男  | 2003-03-12 00:00:00 |   1.75 | 东18舍423
(7 rows)
```

(4) 查询每位学生的学号、学生姓名及其已选修课程的学分总数。

SQL 语句解释：学生只有在成绩及格后才能获得学分，因此使用 SUM 函数统计已选修课程的学分总数时需加上条件判断。此外，S549 表中的部分学生未选修任何课程，在 SC549 表中无相应记录，因此不能使用等值连接，而应使用外连接将两张表连接起来。

```
SELECT S549.Sno, S549.Sname, SUM(CASE WHEN COALESCE(GRADE,0) BETWEEN 60 AND
100 THEN CREDIT ELSE 0 END) AS SUM_CREDIT
FROM S549
      LEFT JOIN SC549 ON S549.Sno=SC549.Sno
      LEFT JOIN C549 ON SC549.Cno=C549.Cno
GROUP BY S549.Sno;
```

```
my_db=> SELECT S549.Sno, S549.Sname, SUM(CASE WHEN COALESCE(GRADE,0) BETWEEN 60 AND
my_db(> 100 THEN CREDIT ELSE 0 END) AS SUM_CREDIT
my_db-> FROM S549
my_db-> LEFT JOIN SC549 ON S549.Sno=SC549.Sno
my_db-> LEFT JOIN C549 ON SC549.Cno=C549.Cno
my_db-> GROUP BY S549.Sno;
   sno    | sname  | sum_credit
---------+--------+------------
 1032005 | 刘静   |          9
 3031051 | 周剑   |          3
 1032001 | 张晓梅 |          9
 1032023 | 孙文   |          6
 3031009 | 田菲   |          8
 3031056 | 曹子衿 |          0
 1032010 | 王涛   |          9
 3031014 | 赵思扬 |          8
 3031033 | 蔡明明 |          8
 1032112 | 董蔚   |          9
 3031011 | 王倩   |          8
(11 rows)
```

(5) 查询选修课程“CS-01”的学生中成绩第二高的学生学号。

```
SELECT Sno, Grade FROM SC549 WHERE Cno='CS-01' AND Grade IN(
SELECT MAX(Grade) FROM SC549 WHERE Cno='CS-01' AND Grade !=
(SELECT MAX(Grade) FROM SC549 WHERE Cno='CS-01'));
```

```
my_db=> SELECT Sno, Grade FROM SC549 WHERE Cno='CS-01' AND Grade IN(
my_db(> SELECT MAX(Grade) FROM SC549 WHERE Cno='CS-01' AND Grade !=
my_db(> (SELECT MAX(Grade) FROM SC549 WHERE Cno='CS-01'));
   sno    | grade
---------+-------
 1032010 |    82
(1 row)
```

(6) 查询平均成绩超过“王涛“同学的学生学号、姓名和平均成绩，并按学号进行降序排列。

```
SELECT Sno, Sname , AvgGrade FROM
(SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC
ON S549.Sno=SC.Sno GROUP BY SC.Sno, S549.Sname) AS Tmp
WHERE AvgGrade > (SELECT AvgGrade FROM
(SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC
ON S549.Sno=SC.Sno
GROUP BY SC.Sno, S549.Sname) WHERE Sname='王涛')
ORDER BY Sno DESC;
```

```
my_db=> SELECT Sno, Sname , AvgGrade FROM
my_db-> (SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
my_db(> FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC
my_db(> ON S549.Sno=SC.Sno GROUP BY SC.Sno, S549.Sname) AS Tmp
my_db-> WHERE AvgGrade > (SELECT AvgGrade FROM
my_db(> (SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
my_db(> FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC
my_db(> ON S549.Sno=SC.Sno
my_db(> GROUP BY SC.Sno, S549.Sname) WHERE Sname='王涛')
my_db-> ORDER BY Sno DESC;
   sno    | sname  |      avggrade
---------+--------+--------------------
 3031033 | 蔡明明 | 91.0000000000000000
 3031011 | 王倩   | 88.5000000000000000
 1032112 | 董蔚   | 88.5000000000000000
(3 rows)
```

(7)查询选修了计算机专业全部课程（课程编号为“CS-××”）的学生姓名及已获得的学分总数。

```
SELECT Sname,SUM(CASE WHEN COALESCE(GRADE,0) BETWEEN 60 AND 100 THEN CREDIT
ELSE 0 END) AS SUM_CREDIT
FROM S549,SC549,C549
WHERE S549.Sno=SC549.Sno AND SC549.Cno=C549.Cno AND NOT EXISTS
(SELECT *
FROM (SELECT Cno FROM C549 WHERE Cno LIKE CONCAT('CS', '%')) AS Cor
WHERE NOT EXISTS
(SELECT *
FROM SC549
WHERE S549.Sno= SC549.Sno AND SC549.Cno= Cor.Cno))
GROUP BY S549.Sno;
```

```
my_db=> SELECT Sname,SUM(CASE WHEN COALESCE(GRADE,0) BETWEEN 60 AND 100 THEN CREDIT ELSE 0 END
) AS SUM_CREDIT
my_db-> FROM S549,SC549,C549
WHERE S549.Sno=SC549.Sno AND my_db-> SC549.Cno=C549.Cno AND NOT EXISTS
my_db->
my_db-> (SELECT *
my_db(> FROM (SELECT Cno FROM C549 WHERE Cno LIKE CONCAT('CS', '%')) AS Cor
my_db(> WHERE NOT EXISTS
my_db(> (SELECT *
my_db(> FROM SC549
my_db(> WHERE S549.Sno= SC549.Sno
my_db(> AND SC549.Cno= Cor.Cno))
my_db-> GROUP BY S549.Sno;
 sname | sum_credit
-------+------------
 董蔚  |          9
(1 row)
```

(8) 查询选修了 3 门以上课程（包括 3 门）的学生中平均成绩最高的同学学号姓名。

```
SELECT ST.Sno, Sname
FROM
( (SELECT S549.Sno Sno
FROM S549 JOIN SC549 SC
ON S549.Sno=SC.Sno
GROUP BY S549.Sno HAVING COUNT(SC.Cno)>=3) AS ST
JOIN
(SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
```

FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC

ON S549.Sno=SC.Sno

GROUP BY SC.Sno, S549.Sname) AS AV

ON ST.Sno=AV.Sno) ORDER BY AvgGrade DESC LIMIT 1;

```
my_db=> SELECT ST.Sno, Sname
my_db-> FROM
my_db-> ( (SELECT S549.Sno Sno
my_db(> FROM S549 JOIN SC549 SC
my_db(> ON S549.Sno=SC.Sno
my_db(> GROUP BY S549.Sno HAVING COUNT(SC.Cno)>=3) AS ST
my_db(> JOIN
my_db(> (SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
my_db(> FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC
my_db(> ON S549.Sno=SC.Sno
my_db(> GROUP BY SC.Sno, S549.Sname) AS AV
my_db(> ON ST.Sno=AV.Sno) ORDER BY AvgGrade DESC LIMIT 1;
   sno   | sname
---------+-------
 1032112 | 董蔚
(1 row)
```

2. 分别在 S549 和 C549 表中加入记录('01032005', '刘竞', '男', '2003-12-10', 1.75, '东 14 舍 312')及('CS-03', "离散数学", 64, 4, '陈建明')。

INSERT INTO S549 VALUES

(01032005,'刘竞','男','1993-12-10',1.75,'东 14 舍 312');

INSERT INTO C549 VALUES

('CS-03','离散数学',64,4,'陈建明');

```
my_db=> INSERT INTO S549 VALUES
my_db-> (01032005,'刘竞','男','1993-12-10',1.75,'东14舍312');
ERROR:  duplicate key value violates unique constraint "s549_pkey"
DETAIL:  Key (sno)=(1032005) already exists.
my_db=> INSERT INTO C549 VALUES
my_db-> ('CS-03','离散数学',64,4,'陈建明');
INSERT 0 1
```

由于主键已经存在，故插入失败。成功在 C549 表中插入一条"CS-03"的记录。

3. 将 S549 表中已修学分数大于 60 的学生记录删除。

DELETE FROM SC549

WHERE Sno IN

(SELECT S549.Sno Sno

FROM S549 JOIN

(SELECT * FROM SC549 WHERE Grade>=60 AND Grade IS NOT NULL) AS SC

ON S549.Sno=SC.Sno

JOIN C549 ON C549.Cno=SC.Cno

GROUP BY S549.Sno HAVING SUM(C549.Credit)>60

) ;

```
my_db=> DELETE FROM SC549
my_db-> WHERE Sno IN
my_db-> (SELECT S549.Sno Sno
my_db(> FROM S549 JOIN
my_db(> (SELECT * FROM SC549 WHERE Grade>=60 AND Grade IS NOT NULL) AS SC
my_db(> ON S549.Sno=SC.Sno
my_db(> JOIN C549 ON C549.Cno=SC.Cno
my_db(> GROUP BY S549.Sno HAVING SUM(C549.Credit)>60);
DELETE 0
```

4. 将“张明”老师负责的“信号与系统”课程的学时数调整为 64，同时增加一个学分。

UPDATE C549 SET Period=64, Credit=Credit+1 WHERE Teacher='张明';

```
my_db=> UPDATE C549 SET Period=64, Credit=Credit+1 WHERE Teacher='张明';
UPDATE 1
my_db=> SELECT * FROM C549;
  cno  |      cname       | period | credit | teacher
-------+------------------+--------+--------+---------
 CS-01 | 数据结构         |     60 |      3 | 张军
 CS-02 | 计算机组成原理   |     80 |      4 | 王亚伟
 CS-04 | 人工智能         |     40 |      2 | 李蕾
 CS-05 | 深度学习         |     40 |      2 | 崔均
 EE-02 | 数字逻辑电路     |    100 |      5 | 胡海东
 EE-03 | 光电子学与光子学 |     40 |      2 | 石韬
 CS-03 | 离散数学         |     64 |      4 | 陈建明
 EE-01 | 信号与系统       |     64 |      4 | 张明
(8 rows)
```

5. 建立如下视图：

(1)居住在“东 18 舍”的男生视图，包括学号、姓名、出生日期、身高等属性

CREATE VIEW V1 AS SELECT * FROM S549 WHERE Sex='男' AND Dorm LIKE '东18%';

```
my_db=> CREATE VIEW V1 AS SELECT * FROM S549 WHERE Sex='男' AND Dorm LIKE '东18%';
CREATE VIEW
my_db=> SELECT * FROM V1;
   sno   | sname  | sex |        bdate        | height |   dorm
---------+--------+-----+---------------------+--------+----------
 3031014 | 赵思扬 | 男  | 2002-06-06 00:00:00 |   1.85 | 东18舍421
 3031051 | 周剑   | 男  | 2002-05-08 00:00:00 |   1.68 | 东18舍422
 3031033 | 蔡明明 | 男  | 2003-03-12 00:00:00 |   1.75 | 东18舍423
(3 rows)
```

(2)“张明”老师所开设课程情况的视图，包括课程编号、课程名称、平均成绩等属性。

```
CREATE VIEW V2 AS
SELECT C549.Cno, C549.Cname, AVG(SC549.Grade)
FROM C549 JOIN SC549 ON C549.Cno = SC549.Cno WHERE Teacher='张明' GROUP BY
C549.Cno, C549.Cname;
```

```
my_db=> CREATE VIEW V2 AS
my_db-> SELECT C549.Cno, C549.Cname, AVG(SC549.Grade)
my_db-> FROM C549 JOIN SC549 ON C549.Cno = SC549.Cno WHERE Teacher='张明' GROUP BY
my_db-> C549.Cno, C549.Cname;
CREATE VIEW
my_db=> SELECT * FROM V2;
  cno  |   cname    |        avg
-------+------------+--------------------
 EE-01 | 信号与系统 | 85.8000000000000000
(1 row)
```

(3)所有选修了“人工智能”课程的学生视图，包括学号、姓名、成绩等属性

```
CREATE VIEW V3 AS
SELECT S549.*
FROM S549 , SC549, C549
WHERE (S549.Sno=SC549.Sno) AND (SC549.Cno=C549.Cno )AND C549.Cname='人工智能'
;
```

```
my_db=> CREATE VIEW V3 AS
my_db-> SELECT S549.*
my_db-> FROM S549 , SC549, C549
my_db-> WHERE (S549.Sno=SC549.Sno) AND (SC549.Cno=C549.Cno )AND C549.Cname='人工智能';
CREATE VIEW
my_db=> SELECT * FROM V3;
   sno   | sname  | sex |        bdate        | height |   dorm
---------+--------+-----+---------------------+--------+----------
 1032010 | 王涛   | 男  | 2003-04-05 00:00:00 |   1.72 | 东6舍221
 1032023 | 孙文   | 男  | 2004-06-10 00:00:00 |   1.80 | 东6舍221
 1032001 | 张晓梅 | 女  | 2004-11-17 00:00:00 |   1.58 | 东1舍312
 1032005 | 刘静   | 女  | 2003-01-10 00:00:00 |   1.63 | 东1舍312
 1032112 | 董蔚   | 男  | 2003-02-20 00:00:00 |   1.71 | 东6舍221
(5 rows)
```

四、完成以下操作，将相应结果截屏保存，并写入实验报告中。

1. 在 S549 表中补充数据至约 1000 行，在 C549 表中补充数据至约 100 行，在 SC549 表中补充数据至约 20000 行。在向 SC549 表中补充数据的过程中，随机选择成绩低于 60 分的 200 行选课记录删除。以上过程不得在同一程序中串行完成。

Python 随机生成数据

在 script/ 目录下创建 expand 文件，在其中写入随机生成的命令。

为保证 SC 表中外键依赖，将生成的 sno 和 cno 储存，在生成 SC 表随机数据时将其随机组合作为主键。

为保证 SC 表中主键唯一，考虑到 python dict 底层为 HASH ，使用 dict 数据结构储存主键

若 dict.get(主键) == True ，说明该主键已生成过，则重新随机生成。

使用迭代器，优化代码结构。

```
import random
import time
import os

S_LEN = 1000
C_LEN = 549
SC_LEN = 2000

SNO_START = int(1033e3)

# yyyy, mm, dd, h, m ,s
date1 = (2002, 1, 1, 0, 0, 0, -1, -1, -1)
time1 = time.mktime(date1)
date2 = (2005, 1, 1, 0, 0, 0, -1, -1, -1)
time2 = time.mktime(date2)

first_name = ["赵", "钱", "孙", "李", "刘","周", "吴", "郑", "王", "冯",
"陈", "褚", "卫", "蒋", "沈", "韩", "杨", "朱", "秦", "尤", "许", "何",
              "吕", "施", "张", "孔", "曹", "严", "华","石", "金", "魏",
"陶", "姜", "戚", "谢", "邹", "喻", "柏", "水", "窦", "章", "云", "苏",
             "潘", "葛", "奚", "范", "彭", "郎", "鲁", "韦", "昌", "马",
"苗", "凤", "花", "方", "俞", "任", "袁", "柳", "酆", "鲍", "史",
```

```
            "唐", "费", "廉", "岑", "薛", "雷", "贺", "倪", "汤", "滕",
"殷", "罗", "毕", "郝", "邬", "安", "常", "乐", "于", "时", "傅",
            "皮", "卞","徐", "齐", "康", "伍", "余", "元", "卜", "顾",
"孟", "平", "黄", "和", "穆", "萧", "尹", "姚", "邵", "堪", "汪"]
last_name = ['玉', '明', '龙', '芳', '军', '玲', '', '立', '玲', '', '国
', "地", "为", "子", "中", "", "", "", "国", "年", "着", "就",
            "那", "和", "要", "刚","她", "出", "也", "", "", "", "自", "
以", "会", "家", "可", "下", "事", "把", "还", "用", "第", "样", "道",
            "想", "作", "种", "开", "美", "总", "从", "无", "情", "己",
"面", "最", "女", "但", "现", "前", "些", "所", "同", "日", "手",
            "又", "行", "丽","意", "动", "方", "期", "它", "头", "经", "
长", "儿", "回", "位", "分", "爱", "老", "因", "很", "给", "名", "法",
            "间", "斯", "知","雪", "世", "什", "两", "次", "使", "身", "
者", "被", "高", "已", "亲", "其", "进", "此", "话", "常", "与", "活",
            "正", "感", "见", "明","建", "问", "力", "理", "尔", "点", "
文", "几", "定", "本", "公", "特", "做", "外", "孩", "相", "西", "果",
            "走", "将", "月", "十", "实", "向", "声", "车", "全", "信",
"重", "三", "机", "工", "物", "气", "每", "并", "别", "真", "打",
            "太", "新", "比", "才", "便", "夫", "再", "书", "部", "水",
"像", "眼", "等", "体", "却", "加", "电", "主", "界", "门", "利",
            "海", "受", "听", "表", "德", "少", "克", "代", "员", "许",
"稜", "先", "口", "由", "死", "安", "写", "性", "马", "光", "白",
            "或", "住", "难", "望", "教", "命", "花", "结", "乐", "色",
"更", "拉", "东", "神", "记", "处", "让", "母", "父", "应", "直",
            "字", "场", "平", "报", "友", "关", "放", "至", "张", "认",
"接", "告", "入", "笑", "内", "英", "军", "候", "民", "岁", "往",
            "何", "度", "山"]
genders = ['女', '男']
dorms = ['东', '西']
sno = SNO_START

first_class = ['深度', '爱情', '经济', '电机', '电路', '数据结构','物理','
数学分析','医学','睡眠', '操作', '数据库', '网络', '计算机组成']
last_class = ['学习', '理论','课程','导论', '教学', '实践','项目', '基础']
deps = ['CS', 'EE','HT','MI','ML', 'SC', 'FI','PH','ST','HH',
'LLM','CV','BA','AI', 'HW']

snos = []
cnos = []

log = open(os.path.join('.', 'expand'), 'w')


def gen_name():
    while True:
```

```
        full_name = random.choice(first_name) +
random.choice(last_name) + random.choice(last_name)
        if len(full_name) > 1:
            return full_name


def record(msg):
    print(msg, end='')
    log.write('%s' % msg)
    log.flush()


record('INSERT INTO S549 VALUES \n')
for i in range(S_LEN):
    count = random.randint(1, 3)
    sno = sno + count
    full_name = gen_name()
    random_time = random.uniform(time1, time2)  # uniform 返回随机实数
time1 <= time < time2
    birthday = time.strftime("%Y-%m-%d", (time.localtime(random_time)))

    gender = random.choice(genders)
    height = random.uniform(1.4, 2.0)
    height = round(height, 2)
    dorm = '%s%d 舍%d%d' % (random.choice(dorms), random.randint(1, 20),
                          random.randint(1, 20), random.randint(1,
22),)
    snos.append(sno)
    if i != S_LEN - 1:
        record("({}, '{}', '{}', '{}', {}, '{}'),\n".format(sno,
full_name, gender, birthday, height, dorm))
    else:
        record("({}, '{}', '{}', '{}', {}, '{}');\n".format(sno,
full_name, gender, birthday, height, dorm))
record('\n\n')


def cache(func):
    ca = {}
    while True:
        args = func()
        if not ca.get(args):
            ca[args] = True
            yield args
```

```
record('INSERT INTO C549 VALUES \n')
cno_gen = cache(lambda: ('%s-%d' % (random.choice(deps),
random.randint(1, 100))))
for i in range(C_LEN):
    cno = next(cno_gen)

    class_name = random.choice(first_class)  +
random.choice(last_class)
    full_name = gen_name()

    ctime = random.randrange(20, 60, 4)

    gender = random.choice(genders)
    credit = random.randrange(1, 13) / 2
    credit = round(credit, 1)
    cnos.append(cno)
    if i != C_LEN - 1:
        record("('{}', '{}', {}, {}, '{}'),\n".format(cno, class_name,
ctime, credit, full_name))
    else:
        record("('{}', '{}', {}, {}, '{}');\n".format(cno, class_name,
ctime, credit, full_name))

record('\n\n')

record('INSERT INTO SC549 VALUES \n')
key_gen = cache(lambda: (random.choice(snos), random.choice(cnos)))
for i in range(SC_LEN):
    key = next(key_gen)
    grade = random.randrange(80, 200) / 2
    grade = round(grade, 1)
    if i != SC_LEN - 1:
        record("({}, '{}', {}),\n".format(key[0], key[1], grade))
    else:
        record("({}, '{}', {});\n".format(key[0], key[1], grade))
record('\n\n')

record('-- Finish')

log.flush()
log.close()
```

JDBC

编写 ExecCommand 函数，可以执行普通操作，如有错则则会提示

```
    public static void ExecCommand(Connection conn, String command)
throws InterruptedException {
        Statement stmt = null;
        try {
            stmt = conn.createStatement();

            stmt.execute(command);

            stmt.close();
            TimeUnit.MICROSECONDS.sleep(1000);

        } catch (SQLException e) {
            System.out.println("Error occurs when executing " +
command);

            if (stmt != null) {
                try {
                    stmt.close();
                } catch (SQLException e1) {
                    e1.printStackTrace();
                }
            }
            e.printStackTrace();
        }
        }
```

编写 ExecSelect 函数，可以执行 SELECT 操作并输出查询结果

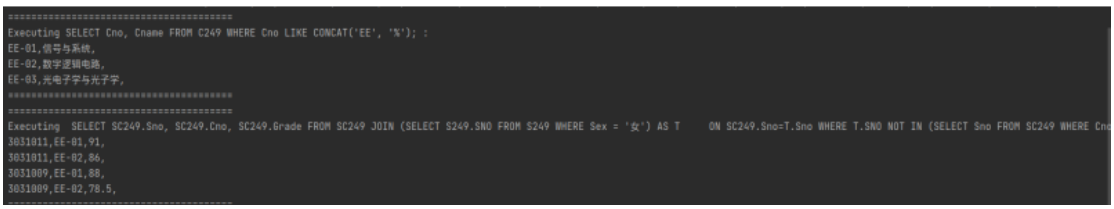
```
    public static void ExecSelect(Connection conn, String sql) {

        Statement stmt =null;
        try {
            stmt = conn.createStatement();
            System.out.println("=====================================
");
            System.out.printf("Executing %s:%n",sql);
            ResultSet rs = stmt.executeQuery(sql);
            String str=null;
            while(rs.next()){
                str = "";
```

```
                for(int i=1;i<=rs.getMetaData().getColumnCount();i++){
                    str += rs.getString(i)+",";
                }
                System.out.println(str);
            }
            if (str == null){
                System.out.println("Found empty!");
            }
            System.out.println("======================================
");
            rs.close();
            stmt.close();
        } catch (SQLException e) {
            if (stmt != null) {
                try {
                    stmt.close();
                }
                catch (SQLException e1) {
                    e1.printStackTrace();
                }
            }
            System.out.println("Error!");
            e.printStackTrace();
            System.out.println("======================================
");

        }
        }
```

输出示例：



编写 ExecFile 函数，可以将文件内的非注释行读入并执行sql 语句

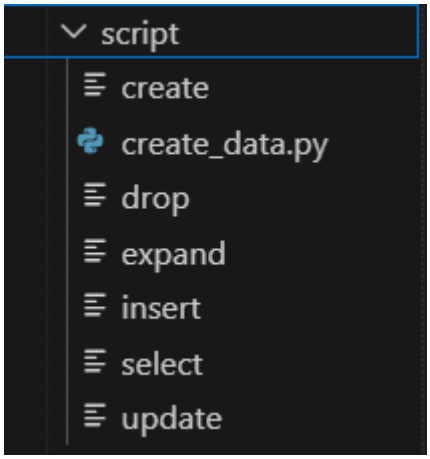
```
    public static void ExecFile(Connection conn, String filename) throws
IOException, InterruptedException {

        FileReader fr=new FileReader(filename);
        BufferedReader br=new BufferedReader(fr);
        String line;
        String buf="";
```

```
        while ((line=br.readLine())!=null) {
            if (!line.contains("--")){
                buf = buf + line + " ";
            }
            if (line.contains(";")){
                if (buf.toLowerCase().contains("select")
& !buf.toLowerCase().contains("create")){
                    ExecSelect(conn, buf);
                }
                else {
                    System.out.println(buf);
                    ExecCommand(conn, buf);
                }
                buf = "";
            }
        }
        br.close();
        fr.close();

        }
```

可以在 script/ 目录下创建若干sql 命令文件，通过 ExecFile 函数读入并执行




```
    public static void main(String[] args){
        //创建数据库连接。
        String USERNAME = "joe";
        String PASSWORD = "ba@2265932745";
        String DB = "my_db";
        Integer PORT = 5432;
        try {
            Connection conn = GetConnection(USERNAME, PASSWORD, DB,
PORT);
            assert conn != null;
```

```
            ExecFile(conn, "./script/drop");

            ExecFile(conn, "./script/create");

            ExecFile(conn, "./script/insert");

            ExecFile(conn, "./script/expand");

            ExecFile(conn, "./script/select");
//
            ExecFile(conn, "./script/update");

            ExecFile(conn, "./script/drop");

            conn.close();

        } catch (SQLException e) {
            e.printStackTrace();
        } catch (IOException | InterruptedException e) {
            throw new RuntimeException(e);
        }
        }
```

```
 01371119 | 刘刚    | 女   | 2002-06-10 00:00:00 |   1.64 | 东1舍307
 01634104 | 石丽丽  | 女   | 2003-10-10 00:00:00 |   1.52 | 东1舍518
 02162088 | 黄芳    | 女   | 2002-02-02 00:00:00 |   1.68 | 东5舍518
 01067322 | 萧雪    | 男   | 2002-06-19 00:00:00 |   1.66 | 东18舍721
 01277960 | 徐建    | 男   | 2004-03-02 00:00:00 |   1.62 | 东17舍406
my_db=> SELECT COUNT(*) FROM S549;
 count
-------
  1018
(1 row)
```

```
 CS-10  | 数据结构基础 |     40 |      2 | 齐芳军
 AI-28  | 数学分析教学 |     52 |      2 | 傅国将
 SC-1   | 数据库基础   |     56 |     .5 | 周回两
 HH-43  | 操作学习     |     48 |    1.5 | 秦比夫
 HW-100 | 爱情基础     |     40 |      5 | 郎结立
 SC-36  | 电机学习     |     52 |    3.5 | 元工便
 LLM-66 | 数据库教学   |     44 |      6 | 袁还间
 MI-60  | 操作项目     |     44 |      4 | 王神每
my_db=> SELECT COUNT(*) FROM C549;
 count
-------
   107
(1 row)
```

```
 02971838 | FI-10 |  76.5
 02461027 | PH-15 |  64.0
 02528210 | ST-95 |  62.5
 02469764 | BA-47 |   1.0
 02698537 | PH-64 |  28.5
my_db=> SELECT COUNT(*) FROM SC549;
 count
-------
 19784
(1 row)
```

2. 在 S549 表中补充数据至约 5490 行，在 C549 表中补充数据至约 1000 行，在 SC549 表中补充数据至约 200000 行。尝试为三、1.中的部分查询（不少于 3 个）编写不同的 SQL 语句实现，分析其运行效率。如果可能，请尝试给出可提高查询效率的改进方法。

```
my_db=> SELECT COUNT(*) FROM S549;
 count
-------
  5021
(1 row)

my_db=> SELECT COUNT(*) FROM C549;
 count
-------
  1022
(1 row)

my_db=> SELECT COUNT(*) FROM SC549;
 count
--------
 200003
(1 row)
```

① 查询未选修课程“CS-02”的女生学号及其已选各课程编号、成绩。

优化前：

```
SELECT SC549.Sno, SC549.Cno, SC549.Grade
FROM SC549 JOIN (SELECT S549.SNO FROM S549  WHERE Sex = '女') AS T
ON SC549.Sno=T.Sno
WHERE T.SNO NOT IN (SELECT Sno FROM SC549 WHERE Cno = 'CS-02');
```

优化后：

```
SELECT SC549.Sno, SC549.Cno, SC549.Grade
FROM SC549 JOIN (SELECT S549.SNO FROM S549 WHERE Sex = '女') AS T
```

```
ON SC549.Sno=T.Sno
WHERE NOT EXISTS (SELECT Sno FROM SC549 WHERE Cno = 'CS-02' AND T.Sno =
sc549.Sno
```

分析：

在本例上性能基本相同，但最好使用NOT EXISTS而不是NOT IN，原因是如果查询语句使用了not in，那么对内外表都进行全表扫描，没有用到索引；而not exists的子查询依然能用到表上的索引。所以无论哪个表大，用not exists都比not in要快。

②查询每位学生的学号、学生姓名及其已选修课程的学分总数。

```
SELECT S549.Sno, S549.Sname, SUM(C549.Credit)
FROM S549, C549, (SELECT * FROM SC549 WHERE Grade>=60 AND Grade IS NOT NULL)
AS SC
WHERE S549.Sno=SC.Sno AND C549.Cno=SC.Cno
GROUP BY S549.Sno;
```

考虑将SC549删除掉成绩不合格或者没有成绩的记录之后再与S549和C549进行连接，然后按照学号进行分组输出结果

③ 查询平均成绩超过“王涛“同学的学生学号、姓名和平均成绩，并按学号进行降序排列。

```
SELECT Sno, Sname , AvgGrade
FROM
(SELECT SC.Sno Sno, S549.Sname Sname, AVG(SC.Grade) AvgGrade
FROM S549 JOIN (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC ON
S549.Sno=SC.Sno
GROUP BY SC.Sno, S549.Sname
HAVING Avggrade >any(
SELECT AVG(SC.Grade) AvgGrade FROM (SELECT * FROM SC549 WHERE
```

```
Grade IS NOT NULL) AS SC WHERE Sno=(SELECT Sno FROM S549 WHERE Sname='王涛')
GROUP BY SC.Sno
)
)
ORDER BY Sno DESC;
```

这条 SQL 语句首先通过连接和聚合计算得到每个学生的平均成绩，然后筛选出平均成绩超过“王涛”同学的学生，最后按学号降序排列结果。通过一个内层子查询 (SELECT * FROM SC549 WHERE Grade IS NOT NULL) AS SC，获取所有成绩不为空的记录，并将其命名为 SC。

接着，通过 S549 JOIN SC ON S549.Sno = SC.Sno，将学生表 S549 与刚才获取的成绩表 SC 按学号 Sno 进行连接，获取每个学生的详细信息和他们的成绩。

然后，使用 GROUP BY SC.Sno, S549.Sname 对这些连接结果按学号和姓名进行分组，计算每个学生的平均成绩 AVG(SC.Grade)，并命名为 AvgGrade。

最后，使用 HAVING AvgGrade > ANY (...) 进行过滤，筛选出平均成绩超过“王涛”同学的学生。这里的 ANY 子查询：首先获取所有成绩不为空的记录，接着根据 Sno = (SELECT Sno FROM S549 WHERE Sname = '王涛') 筛选出“王涛”的成绩记录，并计算“王涛”的平均成绩。因此，HAVING AvgGrade > ANY (...) 的作用是只选择那些平均成绩大于“王涛”同学的学生记录。外部查询从子查询的结果中选择学生的学号 Sno、姓名 Sname 和平均成绩 AvgGrade，并使用 ORDER BY Sno DESC 按学号降序排列结果。

④ 查询选修了计算机专业全部课程（课程编号为“CS-××”）的学生姓名 及已获得的学分总数。

```
SELECT S549.Sname
FROM S549
WHERE NOT EXISTS
(SELECT *
FROM C549 COR
WHERE NOT EXISTS
```

(SELECT *

FROM SC549

WHERE S549.Sno= SC549.Sno

外层查询选择所有满足条件的学生姓名 S549.Sname。条件是 NOT EXISTS 后面的子查询返回结果为假。NOT EXISTS 用于检查子查询是否返回任何行，如果没有返回行则为真。

第一个子查询从课程表 C549 中选择所有课程（使用别名 COR）。条件是对于这些课程，存在一个嵌套的子查询。

嵌套子查询从选课表 SC549 中选择记录，条件是：学生编号 S549.Sno 与 SC549.Sno 匹配。课程编号 SC549.Cno 与 COR.Cno 匹配。课程编号 Cno 以 "CS" 开头。

⑤查询选修了 3 门以上课程（包括 3 门）的学生中平均成绩最高的同学学号及姓名。

SELECT Sno, Sname FROM S549 WHERE Sno = (

SELECT Sno FROM

(SELECT Sno, Grade FROM SC549 WHERE Sno IN

(SELECT S549.Sno Sno

FROM S549 JOIN SC549 SC

ON S549.Sno=SC.Sno

GROUP BY S549.Sno HAVING COUNT(SC.Cno)>=3))

GROUP BY Sno ORDER BY AVG(Grade) DESC LIMIT 1)

分析：

选择学生表 S549 中的学号 (Sno) 和姓名 (Sname)。条件是学生学号必须匹配子查询返回的学号。外层查询的作用是最终返回符合条件的学生的学号和姓名。

从嵌套子查询中选择学号 (Sno)，这个子查询返回平均成绩最高的学生的学号。这个子查询的作用是找到符合条件的学生中成绩最高的学生学号。

这个嵌套子查询从选课表 SC549 中选择学生学号 (Sno) 和成绩 (Grade)，但仅限于那些选修了 3 门及以上课程的学生。结果按平均成绩降序排列，并限制结果只返回一行。嵌套子查询的作用是筛选出符合条件的学生并计算他们的平均成绩，最终找出平均成绩最高的学生。

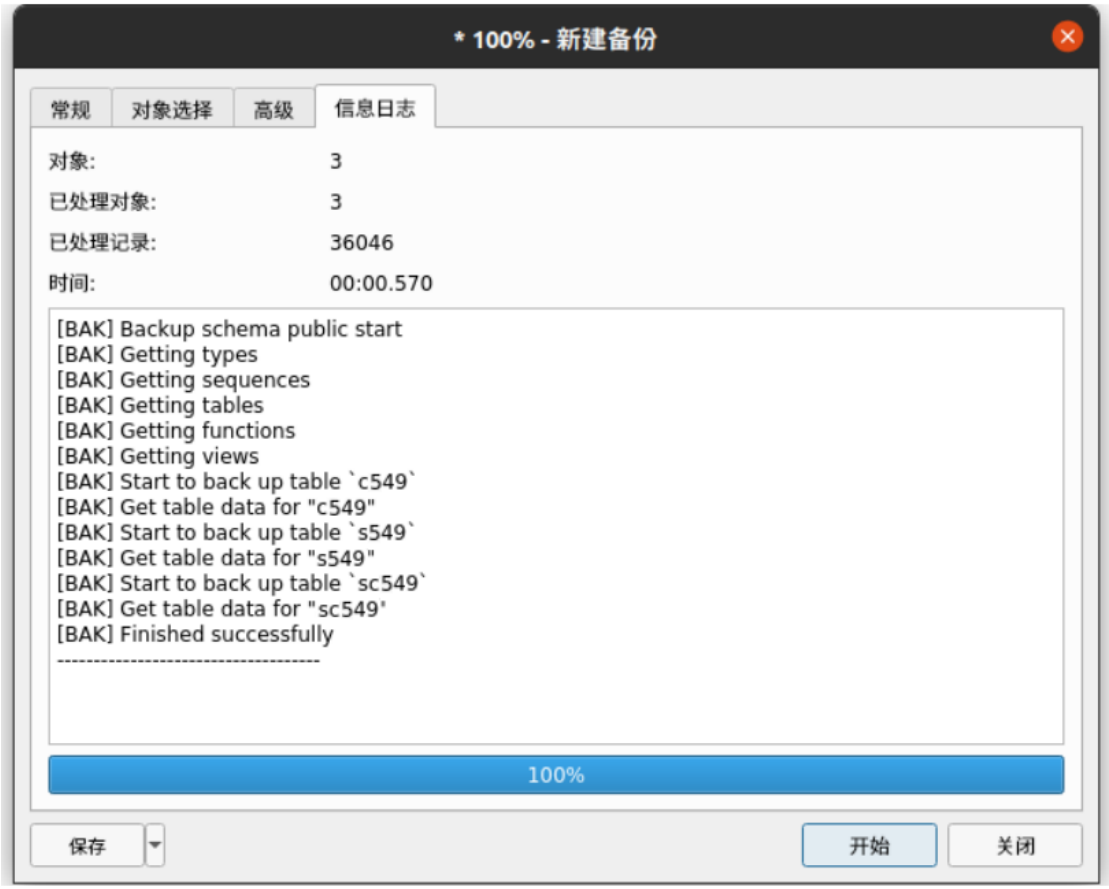
这个子查询从学生表 S549 和选课表 SC549 中选择学号 (S549.Sno)，通过连接操作 (JOIN) 将这两个表按学生学号进行连接。然后使用 GROUP BY 对学号进行分组，并使用 HAVING COUNT(SC.Cno) >= 3 筛选出选修了 3 门及以上课程的学生。嵌套的 IN 子查询的作用是找出所有选修了 3 门及以上课程的学生。

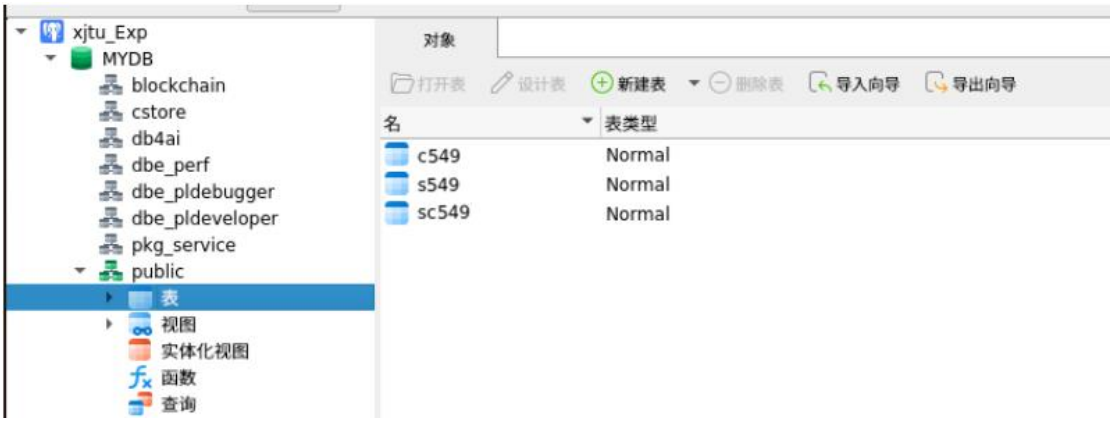
这条 SQL 语句通过多层嵌套查询，首先筛选出选修了 3 门及以上课程的学生，然后在这些学生中计算每个学生的平均成绩，最后选择平均成绩最高的学生，并返回该学生的学号和姓名。

五、完成上述实验内容后，对数据库进行备份，并交给另一位同学进行恢复实验。在成功恢复其他同学交付的数据库备份后，分析其表设计合理性及生成的数据质量，将相应结果截屏图保存，并写入实验报告中。

对数据库进行备份，并交给余小康同学进行恢复实验

```
[omm@guo ~]$ gs_dump -f guo_db.sql -p 26000 my_db
gs_dump[port='26000'][my_db][2023-06-18 00:10:09]: The total objects number is 408.
gs_dump[port='26000'][my_db][2023-06-18 00:10:09]: [100.00%] 408 objects have been dumped.
gs_dump[port='26000'][my_db][2023-06-18 00:10:10]: dump database my_db successfully
```


* 100% - 新建备份
常规
对象选择
高级
信息日志
对象: 3
已处理对象: 3
已处理记录: 36046
时间: 00:00.570
[BAK] Backup schema public start
[BAK] Getting types
[BAK] Getting sequences
[BAK] Getting tables
[BAK] Getting functions
[BAK] Getting views
[BAK] Start to back up table `c549`
[BAK] Get table data for "c549"
[BAK] Start to back up table `s549`
[BAK] Get table data for "s549"
[BAK] Start to back up table `sc549`
[BAK] Get table data for "sc549"
[BAK] Finished successfully
100%
保存
开始
关闭


xjtu_Exp
MYDB
blockchain
cstore
db4ai
dbe_perf
dbe_pldebugger
dbe_pldeveloper
pkg_service
public
表
视图
实体化视图
函数
查询
对象
打开表
设计表
新建表
删除表
导入向导
导出向导
名
表类型
c549 Normal
s549 Normal
sc549 Normal

（2）恢复余小康同学的数据库备份

```
my_db=> select * from s639;
   sno    |  sname   | sex |        bdate        | height |   dorm
----------+----------+-----+---------------------+--------+----------
 01166276 | 陈玉兰   | 男  | 0001-01-01 00:00:00 |   1.76 | 东14舍523
 01227822 | 谢梅     | 男  | 0001-01-01 00:00:00 |   1.75 | 东16舍802
 02417597 | 李萍     | 男  | 0001-01-01 00:00:00 |   1.70 | 东16舍818
 02079670 | 王海燕   | 男  | 0001-01-01 00:00:00 |   1.61 | 东17舍115
 01117747 | 张磊     | 男  | 0001-01-01 00:00:00 |   1.80 | 东18舍210
 01479679 | 徐洋     | 男  | 0001-01-01 00:00:00 |   1.71 | 东16舍216
 01352549 | 连英     | 男  | 0001-01-01 00:00:00 |   1.61 | 东17舍209
 02677533 | 车桂珍   | 女  | 0001-01-01 00:00:00 |   1.71 | 东3舍402
 01530843 | 顾鹏     | 女  | 0001-01-01 00:00:00 |   1.71 | 东4舍702
 02339341 | 娄亮     | 女  | 0001-01-01 00:00:00 |   1.70 | 东2舍521
 01750749 | 萧桂兰   | 男  | 0001-01-01 00:00:00 |   1.70 | 东15舍313
 02645503 | 郝琴     | 男  | 0001-01-01 00:00:00 |   1.68 | 东17舍603
 01814697 | 胡涛     | 男  | 0001-01-01 00:00:00 |   1.68 | 东16舍524
 02190454 | 武强     | 男  | 0001-01-01 00:00:00 |   1.84 | 东17舍609
 02283938 | 张柳     | 男  | 0001-01-01 00:00:00 |   1.72 | 东16舍101
 02815033 | 王勇     | 男  | 0001-01-01 00:00:00 |   1.83 | 东16舍209
 02148780 | 杨丽     | 男  | 0001-01-01 00:00:00 |   1.89 | 东16舍615
 01328069 | 郝云     | 女  | 0001-01-01 00:00:00 |   1.66 | 东1舍314
 02234533 | 马莹     | 女  | 0001-01-01 00:00:00 |   1.64 | 东4舍201
 01661851 | 王荣     | 女  | 0001-01-01 00:00:00 |   1.53 | 东2舍306
 01131472 | 陈宁     | 男  | 0001-01-01 00:00:00 |   1.68 | 东17舍502
 01925952 | 黄旭     | 男  | 0001-01-01 00:00:00 |   1.67 | 东16舍710
 01952399 | 傅丽     | 男  | 0001-01-01 00:00:00 |   1.63 | 东15舍408
```

```
01295002 | 赖敏      | 女   | 0001-01-01 00:00:00 |   1.78 | 东1舍803
my_db=> select * from c639;
 cno   |              cname                | period | credit | teacher
-------+-----------------------------------+--------+--------+---------
CE-50  | 过程装备智能制造基础              |     32 |    2.0 | 邓建强
PH-55  | 体育-2                            |     32 |     .5 | 穆若颖
MA-61  | 公共管理研究方法                  |     32 |    2.0 | 柳江华
PH-03  | 大学物理II-1                      |     64 |    4.0 | 徐忠锋
EL-08  | 控制电机                          |     48 |    2.5 | 孙萍
PH-21  | 体育-4                            |     32 |     .5 | 刘长江
EN-73  | 中国文化翻译                      |     32 |    2.0 | 王芳
ML-08  | 中国近现代史纲要                  |     32 |    2.0 | 郝一博
ME-66  | 基础力学实验-1                    |     16 |     .5 | 黄莺
GN-09  | 大学生职业发展与规划              |     32 |    2.0 | 朱宏伟
CL-63  | 口腔科学                          |     32 |    1.5 | 陈曦
PH-97  | 西方马克思主义                    |     32 |    2.0 | 王赛
LI-68  | 比较文学导论                      |     32 |    2.0 | 魏琛琳
JA-98  | 日本现代社会                      |     32 |    2.0 | 张长安
EN-33  | 医学英语视听说                    |     32 |    2.0 | 张鹏
MA-13  | 工程制图                          |     32 |    2.0 | 苏文军
IN-71  | 工业设计心理学基础                |     40 |    2.0 | 张煜
ME-68  | 材料力学                          |     56 |    3.5 | 文毅
EN-17  | 自动控制原理I                     |     52 |    2.5 | 王珍珍
JZ-96  | 设计实践4                         |     16 |     .5 | 戴靓华
NU-90  | 内科护理学                        |      0 |   72.0 | 3.5
ML-59  | 马克思主义哲学专题研究            |     48 |    3.0 | 晏鹏
```

```
my_db=> select * from sc639;
   sno     |  cno   | grade
-----------+--------+-------
 01638617 | CE-24 |  92.5
 01428188 | IN-92 |  68.0
 02714805 | EA-00 |   3.5
 01555310 | CO-56 |  22.0
 01296491 | GN-75 |   4.0
 01912963 | MA-79 |  77.5
 01539851 | SO-12 |  18.0
 02277667 | PH-48 |  79.0
 01741161 | SC-66 |  92.0
 01492503 | CO-71 |  56.0
 01077516 | FI-63 |  93.5
 01835529 | ME-30 |  57.0
 02855812 | LA-90 |  56.5
 02101091 | EN-61 |   8.0
 02423655 | CE-58 |  64.0
 02532772 | CO-10 |  92.5
 02141549 | CO-37 |  14.5
 01279280 | CE-89 |  38.5
 02384595 | BI-57 |   6.0
 01122654 | MA-01 |  79.5
 01195899 | MA-65 |  82.0
```