数据库课内实验

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1. 实验要求

1. 在openGauss中创建MYDB数据库，并在MYDB中创建学生、课程、选课三个表。
2. 将相应数据加入相应的表中。
3. 完成相应的增删改查操作。
4. 生成数据并插入数据库中。
5. 恢复其他同学的数据库，并简单分析。

2. 实验过程

2.0 前奏

打开数据库

使用虚拟机安装openEuler系统，按照指导书要求安装openGuass数据库，安装完成后尝试开始使用。

```
su - omm
gs_om -t start
```

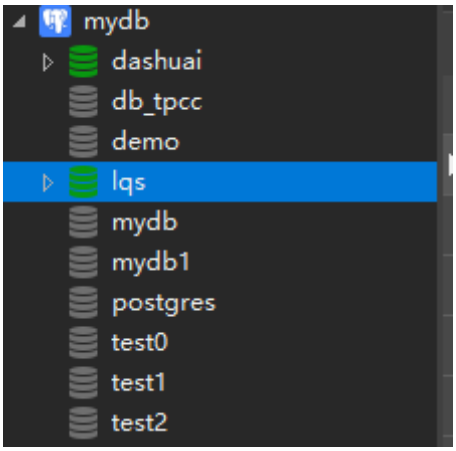
使用MobaXterm连接虚拟机并开启数据库：

```
[omm@lygdb ~]$ gs_om -t start
Starting cluster.
=========================================
=========================================
Successfully started.
[omm@lygdb ~]$ gs_om -t status
-----------------------------------------------------------------------

cluster_name     : dbCluster
cluster_state    : Normal
redistributing   : No

-----------------------------------------------------------------------
[omm@lygdb ~]$
```

新建用户my_root，并使用navicat连接数据库：



在建立表之前想知道**opengauss**的数据类型特点

```
test0=> create table
t1(k char(1)  not null,
test0(> k2 varchar(1) not null);
CREATE TABLE
test0=>
test0=>
test0=>
test0=> insert into t1 values('a', 'b');
INSERT 0 1
test0=> insert into t1 values('a', 'bc');
ERROR:  value too long for type character varying(1)
CONTEXT:  referenced column: k2
test0=> insert into t1 values('aa', 'bb');
ERROR:  value too long for type character(1)
CONTEXT:  referenced column: k
```

char(n)表示存n个字符，而且是对于英文来说的。

```
test0=> insert into t1 values('李','a');
ERROR:  value too long for type character(1)
CONTEXT:  referenced column: k
test0=>
```

一般使用utf-8编码的话，每个汉字占三个字节，也就是3个字符?

我们来尝试一下

```
test0=> create table t2(k1 char(2), k2 char(3), k3 ch
ar(4), k4 char(5), k5 char(6));
CREATE TABLE
test0=> insert into t2 values('李')
test0-> ;
ERROR:  value too long for type character(2)
CONTEXT:  referenced column: k1
```

发现两个字符空间并不能存储一个汉字

```
test0=> insert into t2 values(null, '李')
;
INSERT 0 1
```

三个字符空间却成功了，说明一个汉字就占三个字节。

```
test0=> insert into t2 values(null, '李',null,null,'
李云')
;
INSERT 0 1
```

2.1 建表

先建立一个数据库mydb1。

```
create database mydb1;
```

建表要考虑到数据结构的使用

对于学号要使用char，对于姓名可以使用varchar(150)考虑到有些外国人名字长，性别一般只有一个汉字可以使用char(3)，生日使用Date，身高使用float(2)，宿舍使用5 + 3 + 3 = 11 即可。

课程号使用char(5)，课程名最长为77，使用varchar(77)即可，学时最长为480，所以使用smallint(-32768 ~ 32768)即可，学分最多为50学分，并且可以为小数，使用numeric(3, 1)即可，教师名直接使用varchar(150)。

对于成绩，要比较精确，直接使用numeric(6, 3)。

```
CREATE TABLE S575 (
    Sno CHAR(8) NOT NULL,
    SNAME VARCHAR(150) NOT NULL,
    SEX CHAR(3) NOT NULL,
    BDATE DATE NOT NULL,
    HEIGHT FLOAT(2) DEFAULT 0.0,
    DORM CHAR(15),
    PRIMARY KEY (Sno)
);
CREATE TABLE C575 (
    Cno CHAR(5) NOT NULL,
    CNAME VARCHAR(77) NOT NULL,
    PERIOD SMALLINT NOT NULL,
    CREDIT NUMERIC(3 , 1 ) NOT NULL,
    TEACHER VARCHAR(150) NOT NULL,
    PRIMARY KEY (Cno)
);
CREATE TABLE SC575 (
    Sno CHAR(8) NOT NULL,
    Cno CHAR(5) NOT NULL,
    GRADE NUMERIC(6 , 3 ) DEFAULT NULL,
    PRIMARY KEY (Cno , Sno),
    FOREIGN KEY (Sno)
        REFERENCES S575 (Sno)
        ON DELETE CASCADE,
    FOREIGN KEY (Cno)
        REFERENCES C575 (Cno)
        ON DELETE RESTRICT
);
```

```
mydb1=# CREATE TABLE S575 (
    Sno CHAR(8) NOT NULL,
    SNAME VARCHAR(150) NOT NULL,
    SEX CHAR(3) NOT NULL,
    BDATE DATE NOT NULL,
    HEIGHT FLOAT(2) DEFAULT 0.0,
    DORM CHAR(15),
    PRIMARY KEY (Sno)
);
CREATE TABLE C575 (
    Cno CHAR(5) NOT NULL,
    CNAME VARCHAR(77) NOT NULL,
    PERIOD SMALLINT NOT NULL,
    CREDIT NUMERIC(3 , 1 ) NOT NULL,
    TEACHER VARCHAR(150) NOT NULL,
    PRIMARY KEY (Cno)
);
CREATE TABLE SC575 (
    Sno CHAR(8) NOT NULL,
    Cno CHAR(5) NOT NULL,
    GRADE NUMERIC(6 , 3 ) DEFAULT NULL,
    PRIMARY KEY (Cno , Sno),
    FOREIGN KEY (Sno)
        REFERENCES S575 (Sno)
        ON DELETE CASCADE,
    FOREIGN KEY (Cno)
        REFERENCES C575 (Cno)
        ON DELETE RESTRICT
);
NOTICE:  CREATE TABLE / PRIMARY KEY will create implicit index "s575_pkey" for table "s575"
CREATE TABLE

NOTICE:  CREATE TABLE / PRIMARY KEY will create implicit index "c575_pkey" for table "c575"
CREATE TABLE

NOTICE:  CREATE TABLE / PRIMARY KEY will create implicit index "sc575_pkey" for table "sc575"
CREATE TABLE
```

2.1.1 S表

名	类型	长度	小数点	不是 null	键	注释
sno	char	8	0	☑	🔑1	
sname	varchar	150	0	☑		
sex	char	3	0	☑		
bdate	timestamp	0	0	☑		
height	float4	24	0	☐		
dorm	char	15	0	☐		

2.1.2 C表

名	类型	长度	小数点	不是 null	键
cno	char	5	0	☑	🔑1
cname	varchar	77	0	☑	
period	int2	16	0	☑	
credit	numeric	3	1	☑	
teacher	varchar	150	0	☑	

2.1.3 SC表

sno	char	8	0	☑	🔑2
cno	char	5	0	☑	🔑1
grade	numeric	6	3	☐	

2.2 插入数据

这里使用一种较笨的方法插入数据，使用python的字符串操作生成insert语句，写入数据库中：

```
>>>
================ RESTART: D:\XJTU\大三下专业课\数据库实验\实验过程\python\S.py ====
============
insert into S575 values('01032010','王涛','男','2002-4-5',1.72,'东14舍221')
insert into S575 values('01032023','孙文','男','2003-6-10',1.80,'东14舍221')
insert into S575 values('01032001','张晓梅','女','2003-11-17',1.58,'东1舍312')
insert into S575 values('01032005','刘静','女','2002-1-10',1.63,'东1舍312')
insert into S575 values('01032112','董蔚','男','2002-2-20',1.71,'东14舍221')
insert into S575 values('03031011','王倩','女','2003-12-20',1.66,'东2舍104')
insert into S575 values('03031014','赵思扬','男','2001-6-6',1.85,'东18舍421')
insert into S575 values('03031051','周剑','男','2001-5-8',1.68,'东18舍422')
insert into S575 values('03031009','田婷','女','2002-8-11',1.60,'东2舍104')
insert into S575 values('03031033','蔡明明','男','2002-3-12',1.75,'东18舍423')
insert into S575 values('03031056','曹子衿','女','2003-12-15',1.65,'东2舍305')
insert into C575 values('CS-01','数据结构',60,3,'张军')
insert into C575 values('CS-02','计算机组成原理',80,4,'王亚伟')
insert into C575 values('CS-04','人工智能',40,2,'李蕾')
insert into C575 values('CS-05','深度学习',40,2,'崔均')
insert into C575 values('EE-01','信号与系统',60,3,'张明')
insert into C575 values('EE-02','数字逻辑电路',100,5,'胡海东')
insert into C575 values('EE-03','光电子学与光子学',40,2,'石韬')
insert into SC575 values('01032010','CS-01',82.0)
insert into SC575 values('01032010','CS-02',91.0)
```

检查数据，发现插入成功。

mydb　mydb1　运行　停止　解释

```
1  select * from s575;
```

信息　结果 1

sno	sname	sex	bdate	height	dorm
0103201C	王涛	男	2002-04-05 00:0	1.72	东14舍221
0103202:	孙文	男	2003-06-10 00:0	1.8	东14舍221
01032001	张晓梅	女	2003-11-17 00:0	1.58	东1舍312
0103200:	刘静	女	2002-01-10 00:0	1.63	东1舍312
0103211:	董蔚	男	2002-02-20 00:0	1.71	东14舍221
03031011	王倩	女	2003-12-20 00:0	1.66	东2舍104
0303101:	赵思扬	男	2001-06-06 00:0	1.85	东18舍421
03031051	周剑	男	2001-05-08 00:0	1.68	东18舍422
0303100:	田婷	女	2002-08-11 00:0	1.6	东2舍104
0303103:	蔡明明	男	2002-03-12 00:0	1.75	东18舍423
0303105:	曹子衿	女	2003-12-15 00:0	1.65	东2舍305

2.3 增删改查操作

2.3.1 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。

```sql
SELECT
    Cno,
    CNAME,
    CREDIT
FROM
    c575
WHERE
    Cno LIKE'EE%';
```

信息 结果 1

cno	cname	credit
EE-01	信号与系统	3.0
EE-02	数字逻辑电路	5.0
EE-03	光电子学与光子学	2.0

(2)

查询未选修课程**“CS-01”**的女生学号及其已选各课程编号、成绩。

```sql
SELECT
    sc1.Sno,
    sc1.Cno,
    sc1.Grade
FROM
    sc575 sc1
WHERE
    NOT EXISTS (
    SELECT
        *
    FROM
        sc575 sc2,
        s575 s
    WHERE
        s.SEX = '男'
        AND s.sno = sc1.sno
        OR sc2.Cno = 'CS-01'
        AND sc1.sno = sc2.sno
    ) UNION
SELECT
    s.Sno,
    NULL,
NULL
FROM
    s575 s
```

```sql
WHERE
    s.SEX = '女'
    AND s.sno NOT IN ( SELECT sno FROM sc575 );
```

这里要注意有一部分女生是一门课都没有选的！

sno	cno	grade
03031011	EE-02	86.000
03031011	EE-01	91.000
03031009	EE-01	88.000
03031009	EE-02	78.500
03031056	(Null)	(Null)

(3)

查询**2000**年～**2001**年出生的学生的基本信息。

```sql
SELECT
    *
FROM
    s575
WHERE
    BDATE LIKE'2001%'
    OR Bdate LIKE'2000%';
```

信息 结果 1

sno	sname	sex	bdate	height	dorm
03031014	赵思扬	男	2001-06-06 00:0	1.85	东18舍421
03031051	周剑	男	2001-05-08 00:0	1.68	东18舍422

(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
SELECT
    s575.sno,
    sname,
    SUM ( credit ) AS sum_credit
FROM
    s575,
    c575,
    sc575
WHERE
    s575.sno = sc575.sno
    AND c575.cno = sc575.cno
GROUP BY
    s575.sno
UNION

SELECT
```

```
    s575.sno,
    sname,
    0 AS sum_credit
FROM
    ( s575 LEFT OUTER JOIN sc575 ON ( s575.sno = sc575.sno ) )
WHERE
    sc575.sno IS NULL;
```

信息 结果 1

sno	sname	sum_credit
01032023	孙文	9
03031033	蔡明明	8
01032010	王涛	9
03031011	王倩	8
03031051	周剑	8
01032005	刘静	9
03031056	曹子衿	0
01032001	张晓梅	9
03031014	赵思扬	8
01032112	董蔚	11
03031009	田婷	8

这里注意有一个没有选任何课程的同学，所以在后面多加 了一个unoin。

(5)

查询选修课程**“CS-02”**的学生中成绩第二高的学生学号。

```
SELECT
    sno
FROM
    sc575 sc1
WHERE
    sc1.cno = 'CS-02'
    AND sc1.grade = ( SELECT grade FROM sc575 sc2 WHERE sc2.cno = 'CS-02'
ORDER BY grade DESC LIMIT 1, 1 );
```

信息 结果 1

sno
01032010

(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。

```sql
SELECT
    s1.sno,
    s1.sname,
    AVG ( sc1.grade ) AS avg_grade
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    avg_grade > ALL (
    SELECT AVG
        ( sc2.grade ) AS avg2
    FROM
        sc575 sc2,
        s575 s2
    WHERE
        sc2.sno = s2.sno
        AND s2.sname = '王涛'
    GROUP BY
        s2.sno
    )
ORDER BY
    s1.sno DESC;
```

信息 结果 1

sno	sname	avg_grade
03031033	蔡明明	91.0000000000000000
03031011	王倩	88.5000000000000000
01032112	董蔚	88.5000000000000000

这里考虑是不是有重名的王涛，所以使用了一个`> all`。

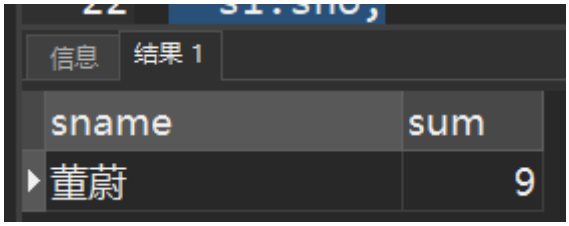
降序要使用一个DESC。

(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。

```sql
SELECT
    s1.sname,
    SUM ( credit )
FROM
    c575 c1,
    s575 s1,
    sc575 sc1
WHERE
    c1.cno = sc1.cno
```

```sql
    AND sc1.sno = s1.sno
    AND NOT EXISTS (
    SELECT
        *
    FROM
        c575 c2
    WHERE
        c2.cno LIKE'CS-%'
        AND NOT EXISTS ( SELECT * FROM sc575 sc3 WHERE sc3.cno = c2.cno AND sc3.sno = s1.sno )
    )
    AND sc1.grade > 60
GROUP BY
    s1.sno;
```



(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及姓名。

```sql
SELECT
    s1.sno,
    s1.sname
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    COUNT ( * ) >= 3
    AND AVG ( sc1.GRADE ) >= (
    SELECT MAX
        ( avg_grade )
    FROM
    ( SELECT AVG ( sc2.GRADE ) AS avg_grade FROM sc575 sc2 GROUP BY sc2.sno HAVING COUNT ( * ) >= 3 ) AS table0
    );
```

2.3.2 添加、删除、修改记录

1. 分别在S×××和C×××表中加入记录(‘01032005’，‘刘竞’，‘男’，‘1993-12-10’，1.75，‘东14舍312’)及(‘CS-03’，“离散数学”，64，4，‘陈建明’)。

```
insert into s575 values ('01032005','刘竞','男','1993-12-10','1.75','东14舍312');
insert into c575 values ('CS-03','离散数学',64,4,'陈建明');
```

```
信息
insert into s575 values ('01032005','刘竞','男','1993-12-10','1.75','东14舍312')
> ERROR:  duplicate key value violates unique constraint "s575_pkey"
DETAIL:  Key (sno)=(01032005) already exists.

> 时间: 0.005s
```

刘竞的学号已经存在了，并且作为主键，所以不能插入。

第二句插入成功：

```
信息
insert into c575 values ('CS-03','离散数学',64,4,'陈建明')
> Affected rows: 1
> 时间: 0.001s
```

2. 将S×××表中已修学分数大于60的学生记录删除。

```
delete from S575
where Sno in
(select SC575.Sno
from SC575,C575
where SC575.Cno = C575.Cno
and SC575.Grade is not null
group by Sno
having sum(C575.Credit) > 60
);
```

```
信息
delete from S575
where Sno in
(select SC575.Sno
from SC575,C575
where SC575.Cno = C575.Cno
and SC575.Grade is not null
group by Sno
having sum(C575.Credit) > 60
)
> Affected rows: 0
> 时间: 0.001s
```

3. 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 C575
set Credit = Credit + 1,  PERIOD = 64
where Cname = '信号与系统'
and Teacher = '张明';
```

```
信息
update C575
set Credit = Credit + 1,  PERIOD = 64
where Cname = '信号与系统'
and Teacher = '张明'
> Affected rows: 1
> 时间: 0.003s
```

2.3.3 视图操作

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。

```sql
create view dong_18_she_nan as
select *
from s575
where s575.DORM like '东18舍%' and sex = '男';
```

```
信息
create view dong_18_she_nan as
select *
from s575
where s575.DORM like '东18舍%' and sex = '男'
> OK
> 时间: 0.011s
```

```sql
6  select * from dong_18_she_nan;
```

信息 结果 1

sno	sname	sex	bdate	height	dorm
03031014	赵思扬	男	2001-06-06 00:0	1.85	东18舍421
03031051	周剑	男	2001-05-08 00:0	1.68	东18舍422
03031033	蔡明明	男	2002-03-12 00:0	1.75	东18舍423

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。

```sql
create view zhangming_c as
select c575.cno, c575.cname, avg(grade) as avg_grade
from c575, sc575
where
c575.cno = sc575.cno and
teacher = '张明'
group by sc575.cno
;
```

```
create view zhangming_c as
select c575.cno, c575.cname, avg(grade) as avg_grade
from c575, sc575
where
c575.cno = sc575.cno and
teacher = '张明'
group by c575.cno
> OK
> 时间: 0.008s
```

```
11 select * from zhangming_c;
```

信息 结果 1

cno	cname	avg_grade
EE-01	信号与系统	85.8000000000000000

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 renzhi_s as
select s575.sno, s575.sname, sc575.grade
from sc575, s575, c575
where sc575.sno = s575.sno
and sc575.cno = c575.cno
and c575.cname = '人工智能';
```

```
create view renzhi_s as
select s575.sno, s575.sname, sc575.grade
from sc575, s575, c575
where sc575.sno = s575.sno
and sc575.cno = c575.cno
and c575.cname = '人工智能'
> OK
> 时间: 0.003s
```

```
8 select * from renzhi_s;
```

信息 结果 1

sno	sname	grade
01032010	王涛	83.5
01032001	张晓梅	83.0
01032005	刘静	82.0
01032023	孙文	76.0
01032112	董蔚	86.0

2.4 生成随机数据并插入并分析效率

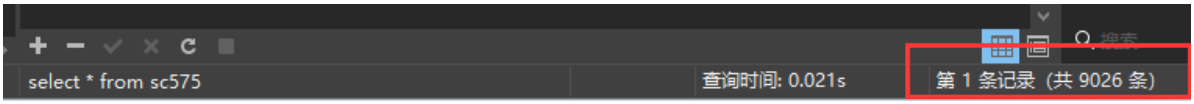
对于课程，我使用Python对于教务处的全校课程表进行了爬取，获得了本学期学校的所有课程信息，共计3910条，但是问题是学校课程记录的CK好像不仅有Cno一个，例如这门国防教育：

```
MILI100554##国防教育##32.0##2.0##问鸿滨,闫忠林,张赟
MILI100554##国防教育##32.0##2.0##初阔林,李科,张昊
MILI100554##国防教育##32.0##2.0##徐宇春,刘玉青,王志朋
MILI100554##国防教育##32.0##2.0##闫忠林,问鸿滨,张赟
MILI100554##国防教育##32.0##2.0##李科,初阔林,张昊
MILI100554##国防教育##32.0##2.0##刘玉青,王志朋,徐宇春
MILI100554##国防教育##32.0##2.0##张赟,问鸿滨,闫忠林
MILI100554##国防教育##32.0##2.0##张昊,初阔林,李科
MILI100554##国防教育##32.0##2.0##王志朋,徐宇春,刘玉青
MILI100554##国防教育##32.0##2.0##问鸿滨,闫忠林,张赟
MILI100554##国防教育##32.0##2.0##初阔林,李科,张昊
```

他们的CK都是一样的，于是为了契合本次实验的要求，我对于这些相同Cno的课程均使用第一条记录作为此课程记录。

2.4.2 第一次插入 + 效率分析

```
连接数据库...
5月 31, 2022 7:34:27 下午 org.postgresql.core.v3.ConnectionFactoryImpl openConnectionImpl
信息: [d7fef935-39e3-401b-9470-d08961b42745] Try to connect. IP: 192.168.56.102:26000
5月 31, 2022 7:34:27 下午 org.postgresql.core.v3.ConnectionFactoryImpl openConnectionImpl
信息: [192.168.56.1:57997/192.168.56.102:26000] Connection is established. ID: d7fef935-39e3-401b-9470-d08961b42745
5月 31, 2022 7:34:27 下午 org.postgresql.core.v3.ConnectionFactoryImpl openConnectionImpl
信息: Connect complete. ID: d7fef935-39e3-401b-9470-d08961b42745
 实例化Statement对象...
yes
9000
49505
Goodbye!
```



插入成功！

查询(5)

写法1

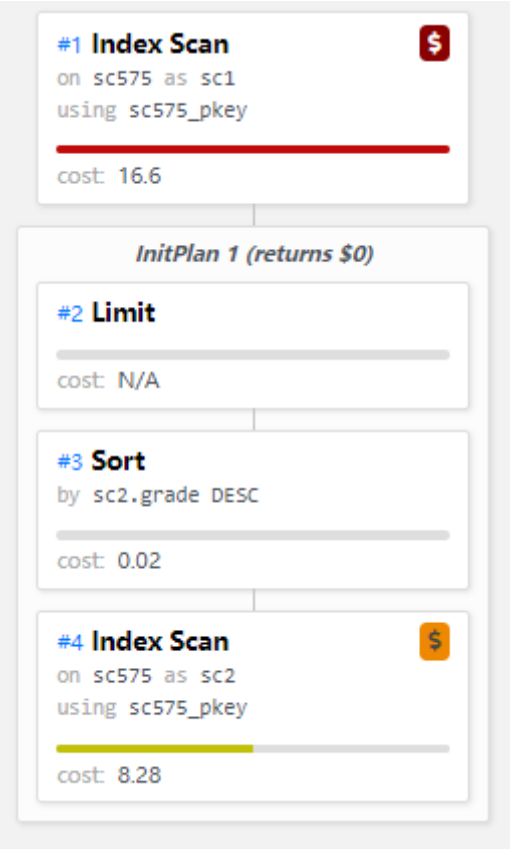
```sql
SELECT
    sno
FROM
    sc575 sc1
WHERE
    sc1.cno = 'CS-02'
    AND sc1.grade = ( SELECT grade FROM sc575 sc2 WHERE sc2.cno = 'CS-02'
ORDER BY grade DESC LIMIT 1, 1 );
```

已知通过explain可以分析一个sql语句的优劣，如下:

```
DER BY grade DESC LIMIT 1, 1 );
                                          QUERY PLAN
-----------------------------------------------------------------------------
---------------
 Index Scan using sc575_pkey on sc575 sc1  (cost=8.30..16.58 rows=1 width=9)
   Index Cond: (cno = 'CS-02'::bpchar)
   Filter: (grade = $0)
   InitPlan 1 (returns $0)
     ->  Limit  (cost=8.30..8.30 rows=1 width=6)
           ->  Sort  (cost=8.29..8.30 rows=1 width=6)
                 Sort Key: sc2.grade DESC
                 ->  Index Scan using sc575_pkey on sc575 sc2  (cost=0.00..8.28
rows=1 width=6)
                       Index Cond: (cno = 'CS-02'::bpchar)
(9 rows)

EXPLAIN
mydb1=#
```

为了让explain的结果更加清晰，我们这里使用expalin.dalibo.com来辅助我们分析：



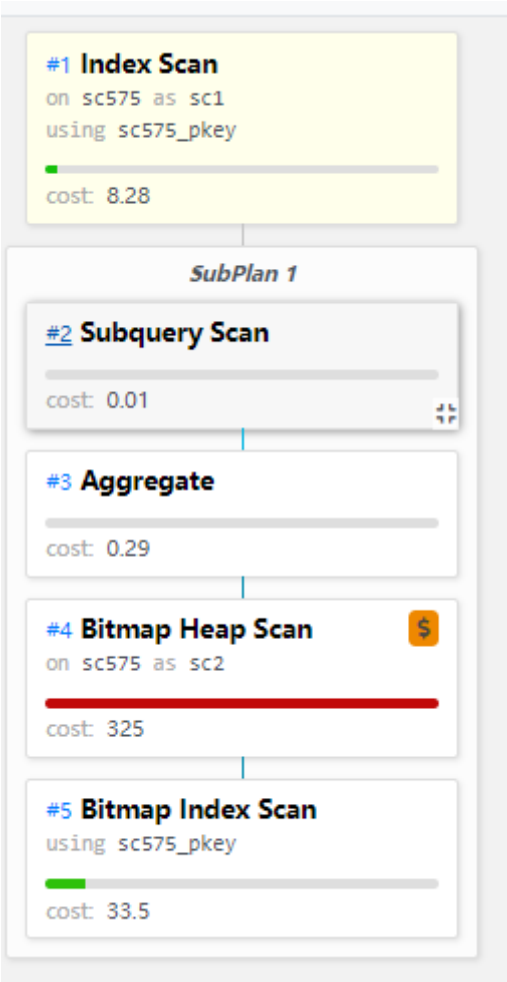
可以看到这个语句，自底向上依次分析：

1. 先使用Index scan，利用主键上的索引查找CS02课程的记录，cost有8.28。
2. 再使用top-N sort对grade排序，找到最大的两条记录，cost很低，估计并没有对所有的记录进行排序。
3. 使用limit函数找到第二大的记录，没有cost。
4. 再使用index scan，利用索引找到所有成绩与第二高成绩相同的记录，cost最高为16.6，因为需要对每条记录进行判断。

写法2

```
    SELECT
    sno
FROM
    sc575 sc1
WHERE
```

```
    sc1.cno = 'CS-02'
    AND EXISTS (
    SELECT
        *
    FROM
        ( SELECT COUNT ( * ) AS count_hi FROM sc575 sc2 WHERE sc2.cno = sc1.cno AND sc2.grade > sc1.grade )
    WHERE
    count_hi = 1
    );
```



这个语句的执行过程：

1. Bitmap Index scan对sc1进行索引扫描，cost为33.5。
2. Bitmap Heap Scan对sc2进行扫描（一次性将满足条件的索引项全部取出，并在内存中进行排序, 然后根据取出的索引项访问表数据）**cost为325**最高。
3. 利用Aggregate判断count(*) = 1，cost很低。
4. Index scan找到满足以上子查询的所有查询结果，cost很低。

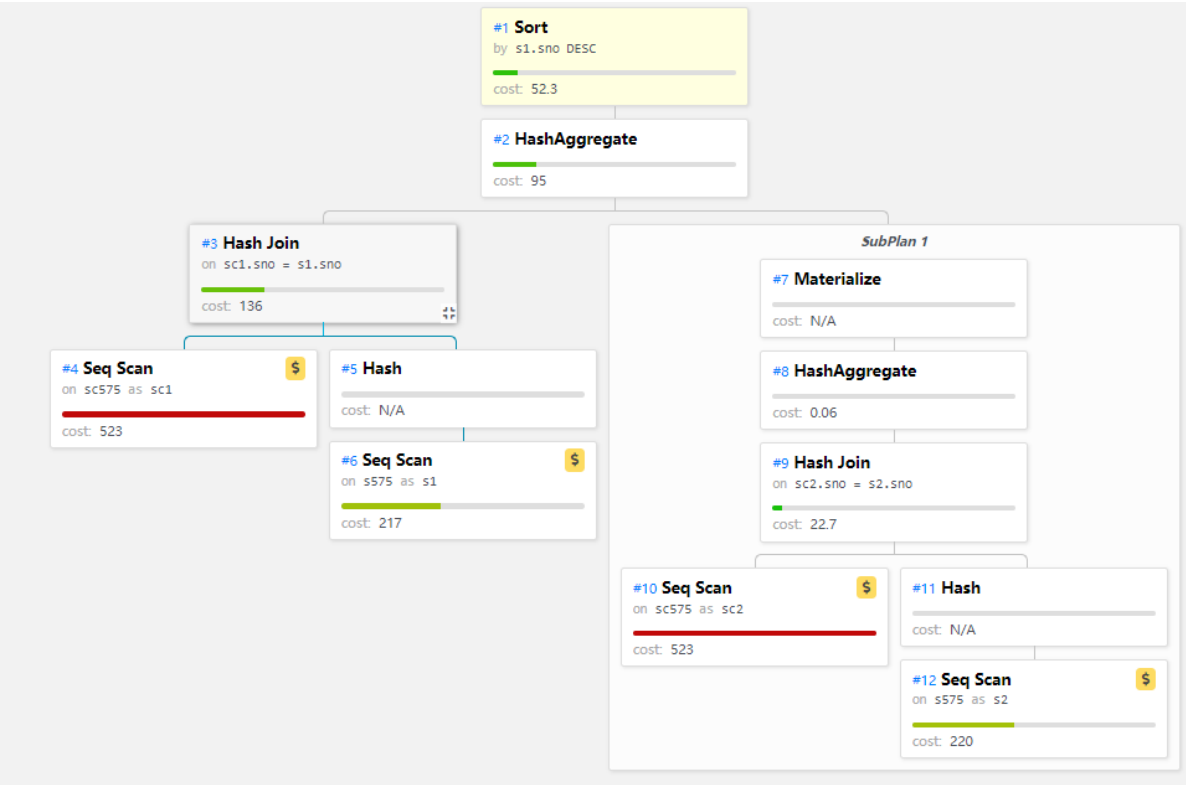
实际上是对于每条sc1记录都执行了一遍子查询，最终返回了sc1的记录，cost较低。

对比这两个查询，还是第一个查询效率更高一些。

查询**(6)**

写法1

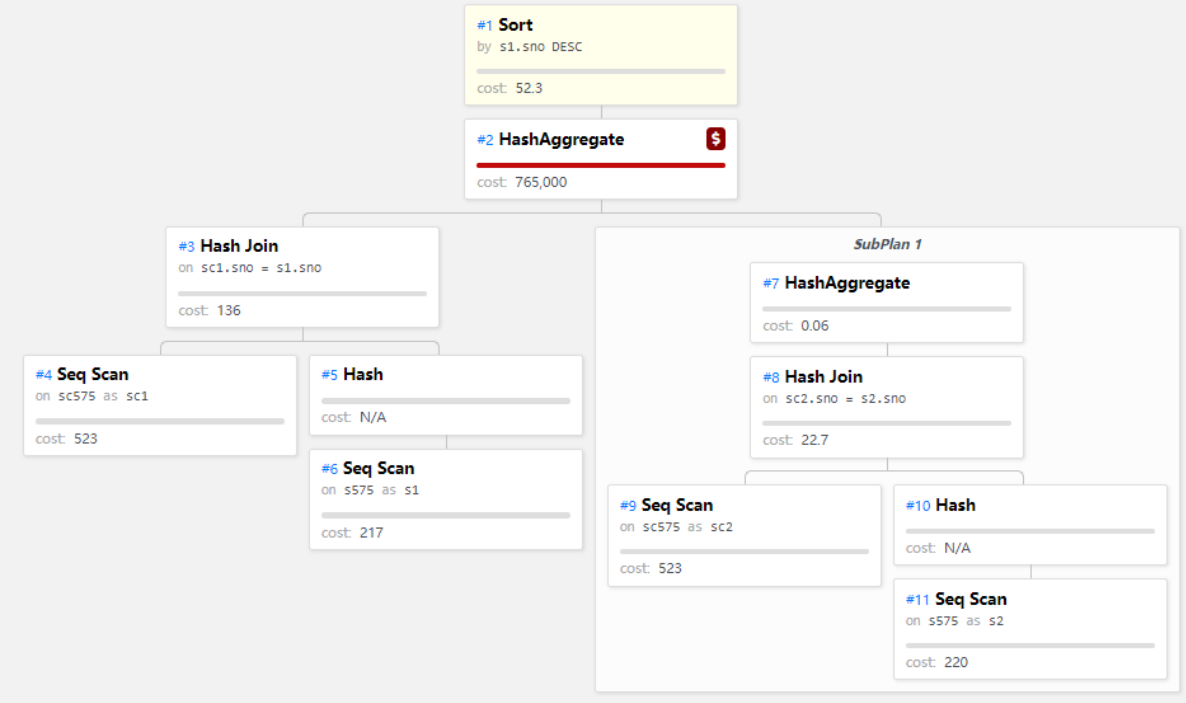
```sql
SELECT
    s1.sno,
    s1.sname,
    AVG ( sc1.grade ) AS avg_grade
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    avg_grade > ALL (
    SELECT AVG
        ( sc2.grade ) AS avg2
    FROM
        sc575 sc2,
        s575 s2
    WHERE
        sc2.sno = s2.sno
        AND s2.sname = '王涛'
    GROUP BY
        s2.sno
    )
ORDER BY
    s1.sno DESC;
```



1. Seq Scan顺序扫描找到王涛，和他的成绩，然后连接，组成了子查询，cost大约为800。
2. 外层查询中也是使用的Seq Scan，cost差不多。

写法2

```sql
SELECT
    s1.sno,
    sname,
    AVG ( sc1.grade ) AS avg_grade
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    EXISTS (
    SELECT
        s2.sno
    FROM
        s575 s2,
        sc575 sc2
    WHERE
        s2.sno = sc2.sno
        AND s2.sname = '王涛'
    GROUP BY
        s2.sno
    HAVING
    AVG ( sc1.grade ) > AVG ( sc2.grade )
    )
    order by s1.sno DESC;
```



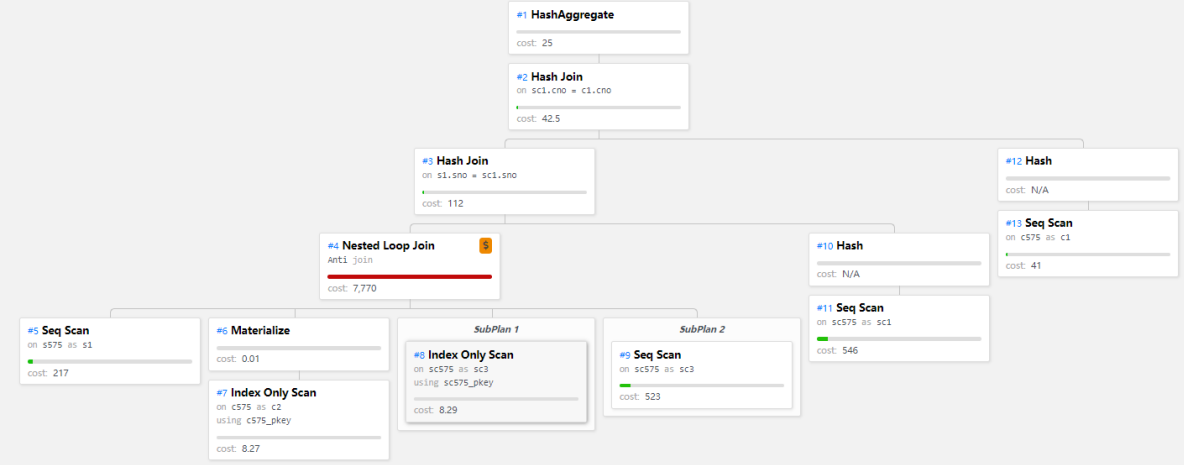
1. 每个自查询中都是使用Seq Scan，效率与写法1差不多。
2. 但是外层使用的not exists，因此每个外层的记录都需要里面查询一遍，这样cost就指数增长，因此这个HashAggregate的cost非常高。

经过比较，还是写法1更好。

查询(7)

写法1

```
SELECT
    s1.sname,
    SUM ( credit )
FROM
    c575 c1,
    s575 s1,
    sc575 sc1
WHERE
    c1.cno = sc1.cno
    AND sc1.sno = s1.sno
    AND NOT EXISTS (
    SELECT
        *
    FROM
        c575 c2
    WHERE
        c2.cno LIKE'CS-%'
        AND NOT EXISTS ( SELECT * FROM sc575 sc3 WHERE sc3.cno = c2.cno AND sc3.sno = s1.sno )
    )
    AND sc1.grade > 60
GROUP BY
    s1.sno;
```

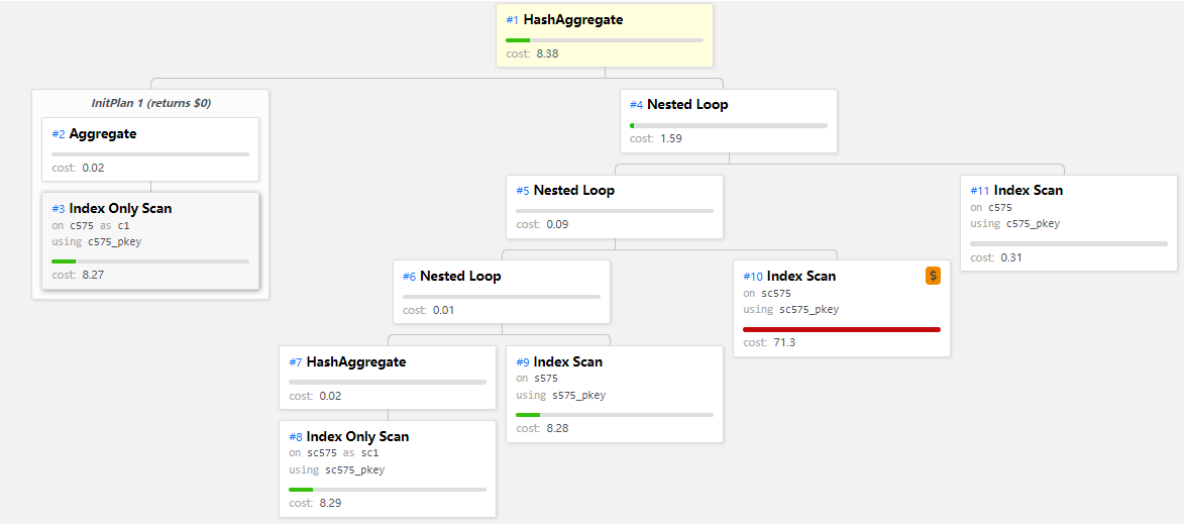


这个主要的cost就在Nested Loop Join这里就是因为这里使用了一个not exists语句，所以cost指数增大为7770。

写法2

```
select sname, sum(credit)
from s575, sc575, c575
where s575.sno = sc575.sno and c575.cno = sc575.cno
and sc575.grade >= 60
and s575.sno in
(
select sno
from
(
select sc1.sno, count(*) as count_cs
from sc575 sc1
```

```sql
where sc1.cno like 'CS-%'
group by sc1.sno
) as t1
where count_cs =
(
select count(*)
from (
select c1.cno
from c575 c1
where c1.cno like 'CS-%'
)
)
)
group by s575.sno
;
```



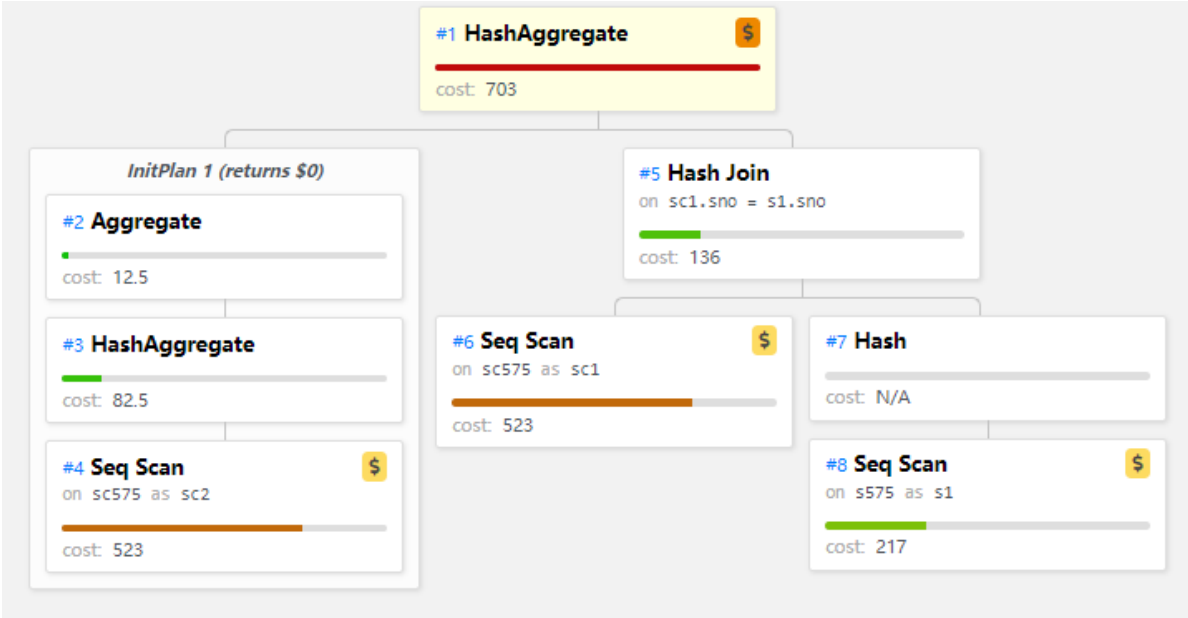
这里直接求取cs课程的数量，对比cs课程数量的多少，cost较少。

应该是写法2更好，但是感觉有点投机取巧的意思。

查询**(8)**

写法**1**

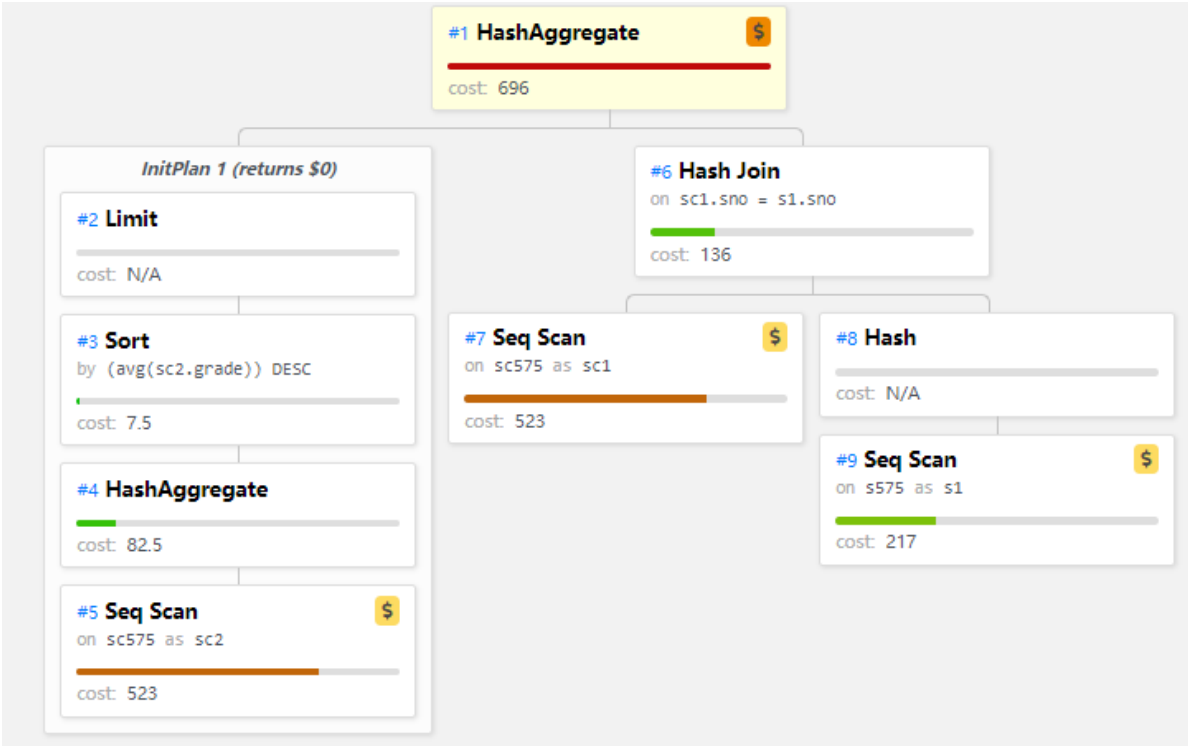
```sql
SELECT
    s1.sno,
    s1.sname
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    COUNT ( * ) >= 3
    AND AVG ( sc1.GRADE ) >= (
    SELECT MAX
        ( avg_grade )
    FROM
    ( SELECT AVG ( sc2.GRADE ) AS avg_grade FROM sc575 sc2 GROUP BY sc2.sno HAVING COUNT ( * ) >= 3 ) AS table0
    );
```



主要的cost在于HashAggregate这里也就是group by，以及两个Seq Scan。

写法2

```
select s1.sno ,s1.sname
from s575 s1, sc575 sc1
where s1.sno = sc1.sno
group by s1.sno
having count(*) >= 3
and avg(sc1.grade) = (
select avg(sc2.grade) as avg_grade
    from sc575 sc2
    group by sc2.sno
    having count(*) >= 3
    order by avg_grade DESC
    limit 1
);
```



二者很类似，基本没有区别。

2.4.2第二次插入 + 效率分析

查询(5)

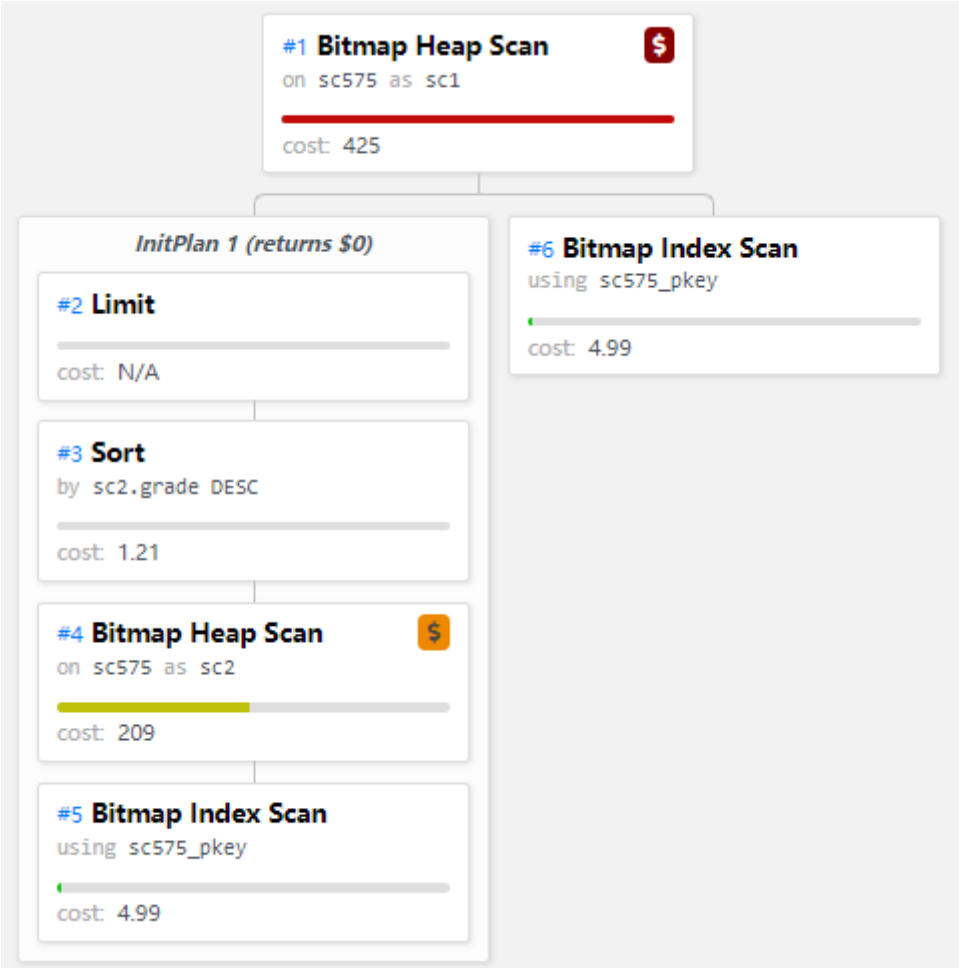
写法1

```sql
SELECT
    sno
FROM
    sc575 sc1
WHERE
    sc1.cno = 'CS-02'
    AND sc1.grade = ( SELECT grade FROM sc575 sc2 WHERE sc2.cno = 'CS-02'
ORDER BY grade DESC LIMIT 1, 1 );
```

已知通过explain可以分析一个sql语句的优劣。

```
mydb1=# explain SELECT
        sno
FROM
        sc575 sc1
WHERE
        sc1.cno = 'CS-02'
        AND sc1.grade = ( SELECT grade FROM sc575 sc2 WHERE sc2.cno = 'CS-02' OR
DER BY grade DESC LIMIT 1, 1 );
                                          QUERY PLAN
-----------------------------------------------------------------------------
--------------
 Bitmap Heap Scan on sc575 sc1  (cost=220.35..429.97 rows=1 width=9)
   Recheck Cond: (cno = 'CS-02'::bpchar)
   Filter: (grade = $0)
   InitPlan 1 (returns $0)
     ->  Limit  (cost=215.36..215.36 rows=1 width=6)
           ->  Sort  (cost=215.36..215.60 rows=97 width=6)
                 Sort Key: sc2.grade DESC
                 ->  Bitmap Heap Scan on sc575 sc2  (cost=5.01..214.39 rows=97 w
idth=6)
                       Recheck Cond: (cno = 'CS-02'::bpchar)
                       ->  Bitmap Index Scan on sc575_pkey  (cost=0.00..4.99 row
s=97 width=0)
                             Index Cond: (cno = 'CS-02'::bpchar)
   ->  Bitmap Index Scan on sc575_pkey  (cost=0.00..4.99 rows=97 width=0)
         Index Cond: (cno = 'CS-02'::bpchar)
(13 rows)

EXPLAIN
```

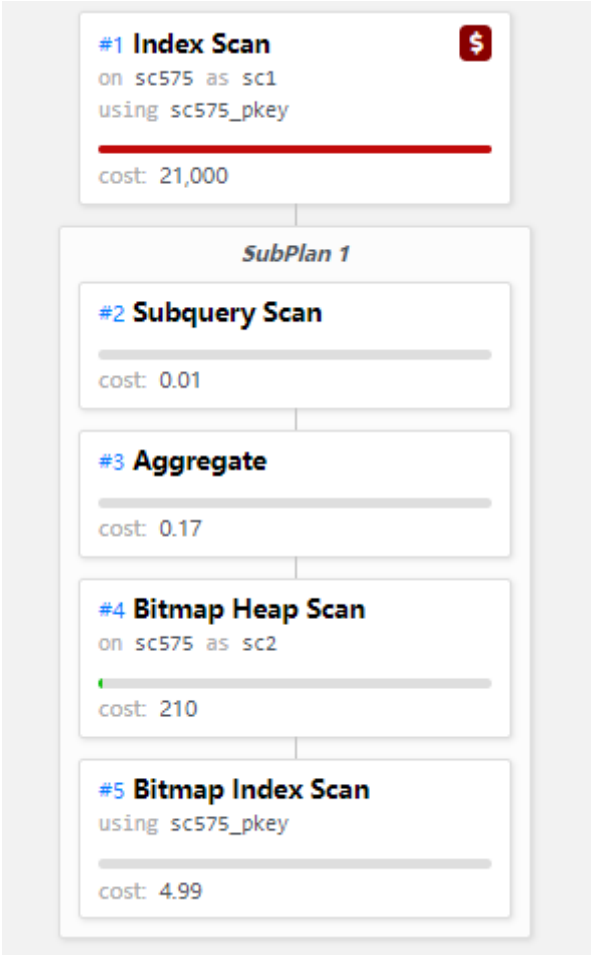


数据量大了之后查询plan显然发生了变化：

之前是使用的Seq Scan，这里使用的Bitmap Index Scan，对于大量记录更为有效。

写法2

```
    SELECT
    sno
FROM
    sc575 sc1
WHERE
    sc1.cno = 'CS-02'
    AND EXISTS (
    SELECT
        *
    FROM
        ( SELECT COUNT ( * ) AS count_hi FROM sc575 sc2 WHERE sc2.cno = sc1.cno AND sc2.grade > sc1.grade )
    WHERE
    count_hi = 1
    );
```



这个查询与数据量小时候的plan是一致的，这里的外层查询显然cost要高很多。

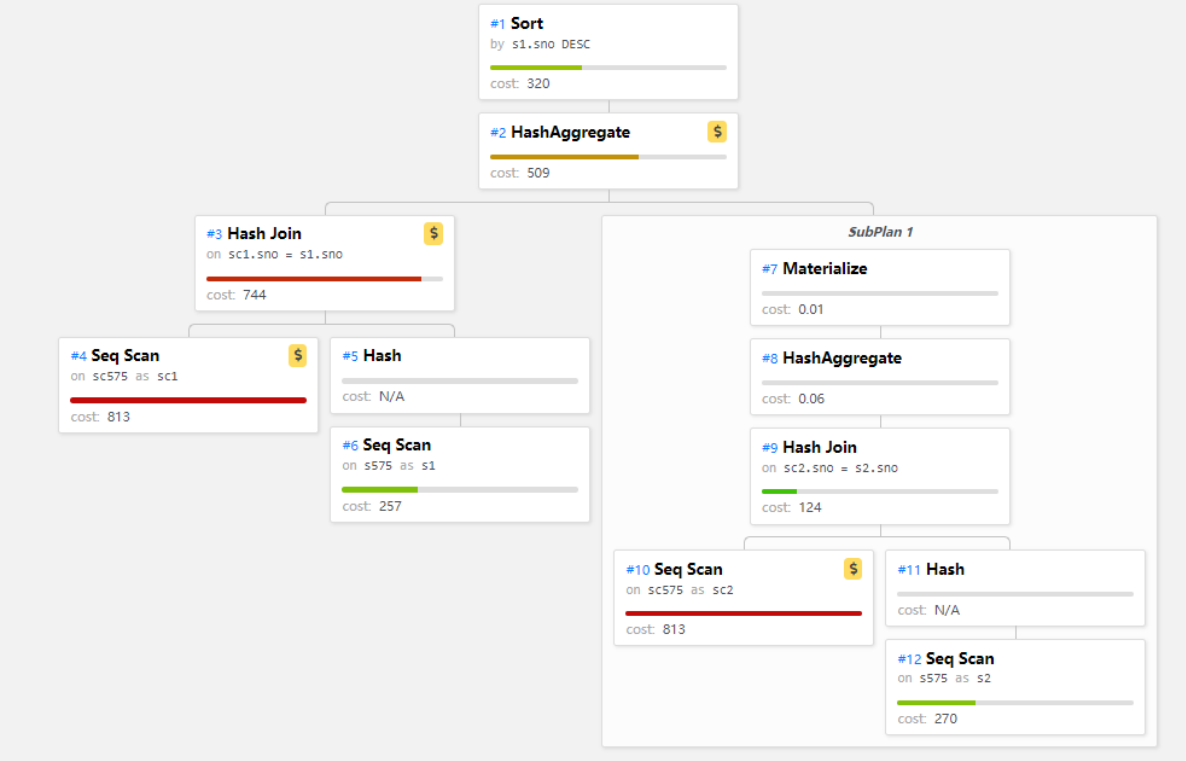
这里显然写法1效率要更高。

查询(6)

写法1

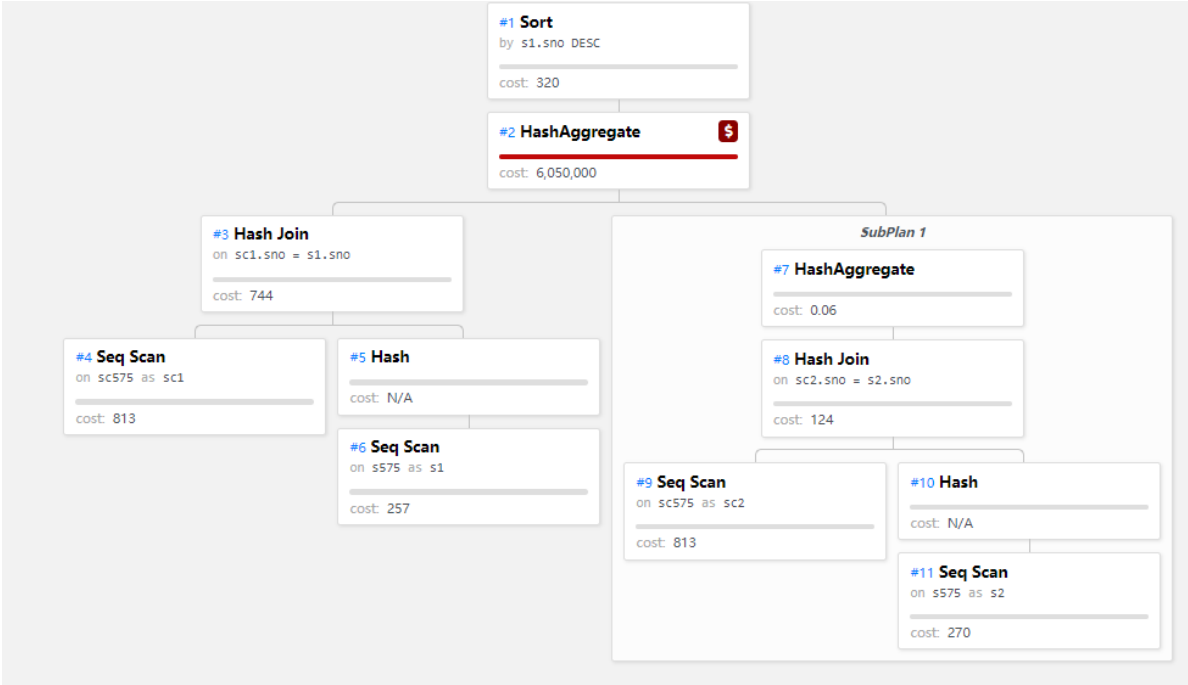
```
SELECT
    s1.sno,
    s1.sname,
    AVG ( sc1.grade ) AS avg_grade
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    avg_grade > ALL (
    SELECT AVG
        ( sc2.grade ) AS avg2
    FROM
        sc575 sc2,
        s575 s2
    WHERE
        sc2.sno = s2.sno
        AND s2.sname = '王涛'
    GROUP BY
        s2.sno
```

```
    )
ORDER BY
    s1.sno DESC;
```



写法2

```
SELECT
    s1.sno,
    sname,
    AVG ( sc1.grade ) AS avg_grade
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    EXISTS (
    SELECT
        s2.sno
    FROM
        s575 s2,
        sc575 sc2
    WHERE
        s2.sno = sc2.sno
        AND s2.sname = '王涛'
    GROUP BY
        s2.sno
    HAVING
    AVG ( sc1.grade ) > AVG ( sc2.grade )
    )
    order by s1.sno DESC;
```



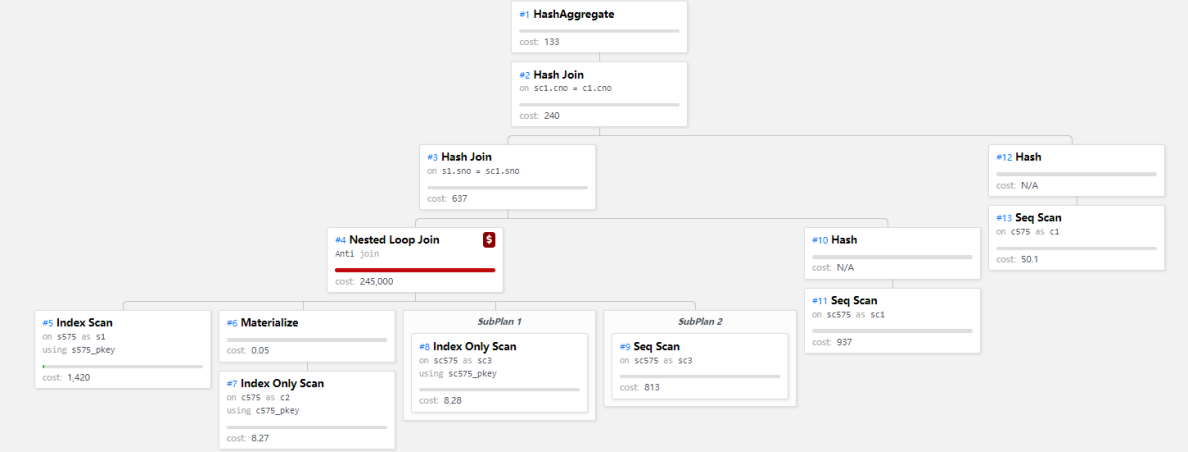
这里由于使用了exists所以叠加起来的cost较大。

因此写法1更好点。

查询(7)

写法1

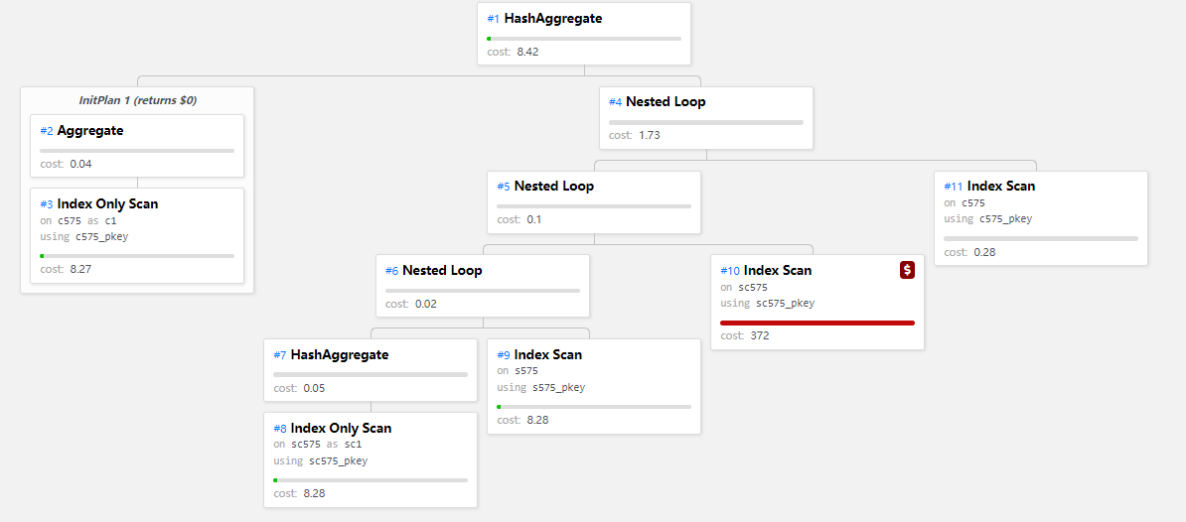
```
SELECT
    s1.sname,
    SUM ( credit )
FROM
    c575 c1,
    s575 s1,
    sc575 sc1
WHERE
    c1.cno = sc1.cno
    AND sc1.sno = s1.sno
    AND NOT EXISTS (
    SELECT
        *
    FROM
        c575 c2
    WHERE
        c2.cno LIKE'CS-%'
        AND NOT EXISTS ( SELECT * FROM sc575 sc3 WHERE sc3.cno = c2.cno AND sc3.sno = s1.sno )
    )
    AND sc1.grade > 60
GROUP BY
    s1.sno;
```



写法2

```
select sname, sum(credit)
from s575, sc575, c575
where s575.sno = sc575.sno and c575.cno = sc575.cno
and sc575.grade >= 60
and s575.sno in
(
select sno
from
(
select sc1.sno, count(*) as count_cs
from sc575 sc1
where sc1.cno like 'CS-%'
group by sc1.sno
) as t1
where count_cs =
(
select count(*)
from (
select c1.cno
from c575 c1
where c1.cno like 'CS-%'
)
)
)
group by s575.sno
;
```

```
                                                QUERY PLAN
-------------------------------------------------------------------------------------------------------------
 HashAggregate  (cost=91.38..91.44 rows=6 width=53)
   Group By Key: s575.sno
   InitPlan 1 (returns $0)
     ->  Aggregate  (cost=4.25..4.26 rows=1 width=8)
           ->  Seq Scan on c575 c1  (cost=0.00..4.25 rows=1 width=0)
                 Filter: (cno ~~ 'CS-%'::text)
   ->  Nested Loop  (cost=8.28..87.09 rows=6 width=21)
         ->  Nested Loop  (cost=8.28..85.39 rows=6 width=23)
               ->  Nested Loop  (cost=8.28..16.59 rows=1 width=26)
                     ->  HashAggregate  (cost=8.28..8.30 rows=1 width=25)
                           Group By Key: sc1.sno
                           Filter: (count(*) = $0)
                           ->  Index Only Scan using sc575_pkey on sc575 sc1  (cost=0.00..8.28 rows=1 width=9)
                                 Index Cond: ((cno >= 'CS-'::bpchar) AND (cno < 'CS.'::bpchar))
                                 Filter: (cno ~~ 'CS-%'::text)
                     ->  Index Scan using s575_pkey on s575  (cost=0.00..8.27 rows=1 width=17)
                           Index Cond: (sno = sc1.sno)
               ->  Index Scan using sc575_pkey on sc575  (cost=0.00..68.71 rows=9 width=15)
                     Index Cond: (sno = s575.sno)
                     Filter: (grade >= 60::numeric)
         ->  Index Scan using c575_pkey on c575  (cost=0.00..0.27 rows=1 width=10)
               Index Cond: (cno = sc575.cno)
(22 rows)
```

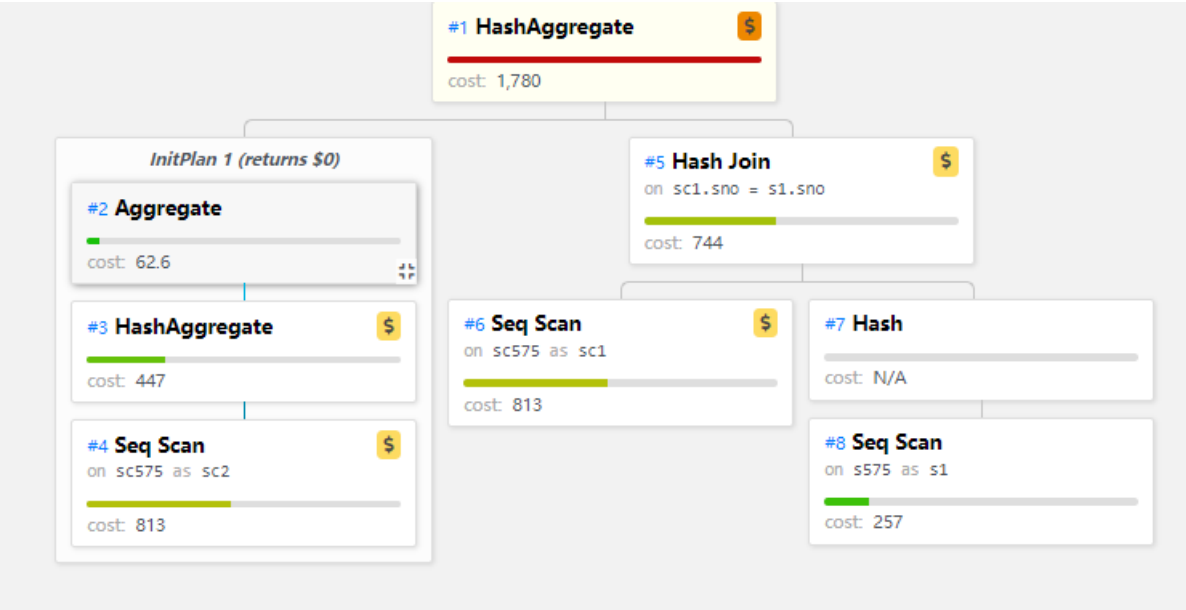


这个查询的情况与数据量小的时候类似。

查询(8)

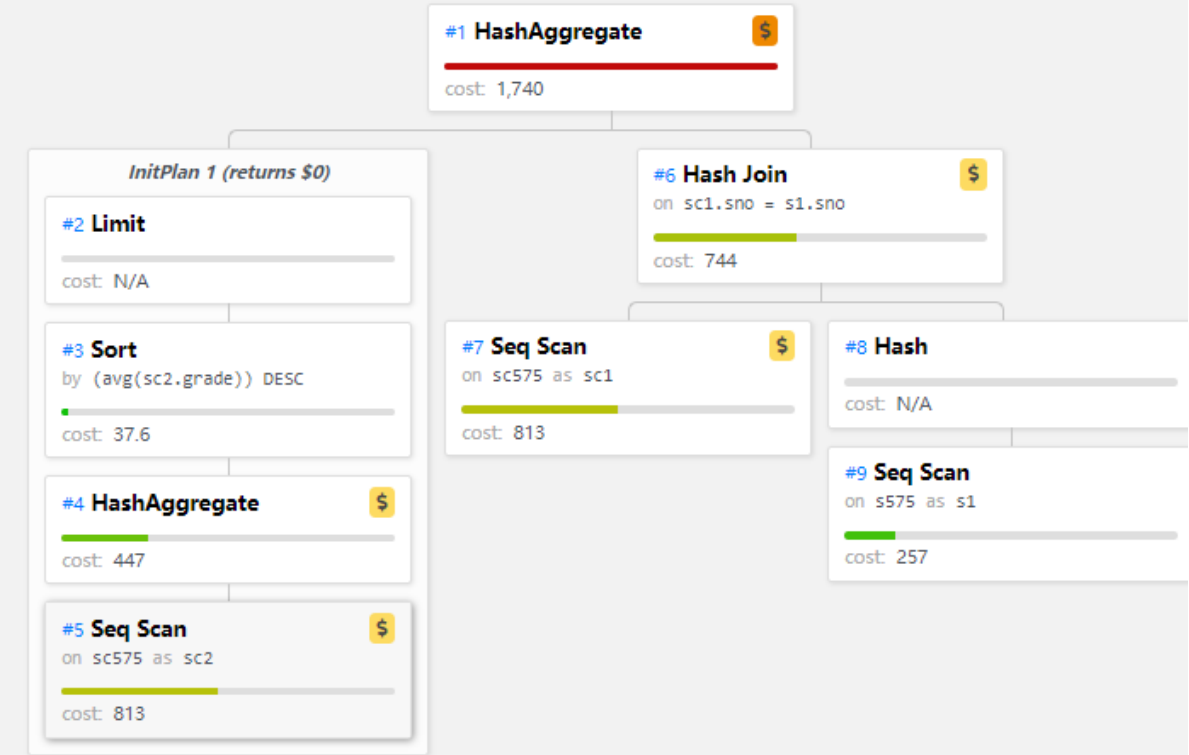
写法1

```
SELECT
    s1.sno,
    s1.sname
FROM
    s575 s1,
    sc575 sc1
WHERE
    s1.sno = sc1.sno
GROUP BY
    s1.sno
HAVING
    COUNT ( * ) >= 3
    AND AVG ( sc1.GRADE ) >= (
    SELECT MAX
        ( avg_grade )
    FROM
    ( SELECT AVG ( sc2.GRADE ) AS avg_grade FROM sc575 sc2 GROUP BY sc2.sno HAVING COUNT ( * ) >= 3 ) AS table0
    );
```



写法2

```
select s1.sno ,s1.sname
from s575 s1, sc575 sc1
where s1.sno = sc1.sno
group by s1.sno
having count(*) >= 3
and avg(sc1.grade) = (
select avg(sc2.grade) as avg_grade
    from sc575 sc2
    group by sc2.sno
    having count(*) >= 3
    order by avg_grade DESC
    limit 1
);
```



与数据量小的时候类似。

2.4.3 提高效率

要提高效率可以

- 改变语句的逻辑或写法。
- 在相应属性添加索引。

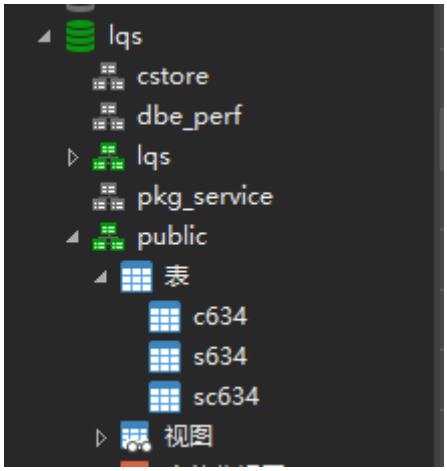
2.5 交换数据库并恢复

数据库备份来源----计算机91 刘青帅

使用navicat直接进行备份的还原，还原的时候要注意新建一个与源数据库用户一致的用户名，以免没有建表的权限。

这里新建一个lqs用户，并且赋予管理员权限。

然后直接还原即可：



还原成功，然后简单分析一下这个表：

2.5.1 S表

名	类型	长度	小数点	不是 null	键
sno	char	10	0	☑	1
sname	varchar	20	0	☑	
sex	char	6	0	☑	
bdate	timestamp	0	0	☑	
height	numeric	3	2	☐	
dorm	varchar	30	0	☑	

sno长度固定且为8，这里感觉没有必要给长度为10；

sname长度为20太短了，考虑到会有留学生，长度应该加长；

2.5.2 C表

名	类型	长度	小数点	不是 null	键
cno	char	10	0	☑	1
cname	varchar	160	0	☑	
period	int2	16	0	☑	
credit	numeric	2	1	☑	
teacher	varchar	40	0	☑	

这里我发现teacher的varchar长度仅仅给了40，我感觉这里没有考虑到会有外教，名字比较长的情况。

cno的长度固定且均为5，在这里给长度为10我感觉没有必要。

2.5.3 SC表

名	类型	长度	小数点	不是 null	键
sno	char	10	0	☑	1
cno	char	10	0	☑	2
grade	numeric	4	1	☐	

SC表比较好。

2.5.4 数据质量

cno	cname	period	credit	teacher
CS-01	数据结构	60	3.0	张军
CS-02	计算机组成原理	80	4.0	王亚伟
CS-04	人工智能	40	2.0	李蕾
CS-05	深度学习	40	2.0	崔均
EE-02	数字逻辑电路	100	5.0	胡海东
EE-03	光电子学与光子学	40	2.0	石韬
JS-106	《左传》导读	20	1.0	许昭
RW-107	社会组织管理	120	6.0	王社民
JJ-108	国际市场调研与预	40	2.0	范爱莉
RJ-109	环境系统监测	70	3.5	陈芯莹
JX-110	工程制图	80	4.0	何平
SM-111	遗传学实验	90	4.5	何效增
HX-112	有机化学Ⅰ-2	100	5.0	冯骥磊
CS-03	离散数学	64	4.0	陈建明
EE-01	信号与系统	64	4.0	张明
YX-113	医学微生物学	60	3.0	汪敏强
YX-114	生物化学	30	1.5	权芳
WG-115	日语写作实践	70	3.5	赵宏亮
HX-116	医用有机化学实验	50	2.5	陈晓黎
CL-117	材料科学基础-1	20	1.0	范艳蕊

21223182	冯学军	女	2002-10-08 00:0	1.74	东17舍516
14857721	何森	女	2003-05-11 00:0	1.63	北7舍723
07986625	葛金琰	女	1999-06-27 00:0	1.77	南11舍104
91230268	周志淳	女	1999-08-06 00:0	1.51	南1舍925
04569293	朱卫	男	2001-10-17 00:0	1.81	北13舍903
31970095	杜正春	女	2000-09-20 00:0	1.58	南0舍004
30648078	王瑞	女	2002-01-28 00:0	1.56	西0舍411
53407417	苏国利	女	1999-05-22 00:0	1.61	北15舍929
54085108	范俊梅	男	2000-10-19 00:0	1.62	西19舍825
93359913	何德杰	女	2001-03-03 00:0	1.59	北14舍018
69228894	朱增	男	1997-04-18 00:0	1.85	西2舍120
37210262	刘广庆	女	1998-09-21 00:0	1.79	东18舍616
36474674	周晓文	女	1998-05-13 00:0	1.65	南12舍700
67789563	苏立明	男	1998-06-06 00:0	1.84	南15舍803
40358800	赖天伟	男	2002-06-19 00:0	1.64	东4舍427
69131935	赵文振	女	2001-06-26 00:0	1.57	北14舍004
85863838	陈丽敏	女	2002-01-25 00:0	1.63	西0舍114

生成数据质量较好，课程的信息均为教务处爬取的，好像学生的信息是使用teacher的名字相互组合而成的，非常有真实性。

3 实验总结

本次实验收获了很多，列举如下：

- 学会了配置openguass环境，配置本地虚拟机以及使用navicat进行连接。
- 学会了使用navicat进行数据库的操作。
- 学会了使用JDBC连接数据库并且生成随机数据插入数据库。
- 学会了使用爬虫爬取网页内容。
- 学会了使用explain语句进行sql查询的效率分析。

4 附录

4.1 生成初始数据 --- python源码

init_data.py

```python
f = open("S575.txt", 'r',encoding = 'utf-8')

line = f.readline()

while(line != ''):
    y = line.split()

    line = f.readline()

    print("insert into S575 values('" + y[0] + "','" + y[1] + "','" + y[2] + "','" + y[3] + "'," + str(y[4]) + ",'" + y[5] + "')")
```

```python


f.close()


f = open("C575.txt", "r", encoding = 'utf-8')

line = f.readline()

while(line != ''):
    y = line.split()
    line = f.readline()
    print("insert into C575 values('" + y[0] + "','" + y[1] + "'," + str(y[2]) + "," + str(y[3]) +",'" + y[4] + "')")
f.close()


f = open("SC575.txt", "r", encoding = 'utf-8')

line = f.readline()

while(line != ''):
    y = line.split()
    line = f.readline()
    if(len(y) == 2):
        print("insert into SC575 values('" + y[0] + "','" + y[1] + "'," + "NULL" + ")")
    else:
        print("insert into SC575 values('" + y[0] + "','" + y[1] + "'," + y[2] + ")")

```

4.2 爬取教务处课程表 --- python源码

getcourse.py

```python
import requests
import json
req = requests.session()

dic = {}
# 这里的cookie是随时间变换的，每次需要使用不一样的cookie
with open('cookie.txt', 'r') as file_obj:
    cookie = file_obj.read()
f = open("course.txt", "w")
for ii in range(1, 1000):


    data = {'querySetting': '''
    [{"name":"XNXQDM","value":"2021-2022-2","linkOpt":"and","builder":"equal"},[{"name":"RWZTDM","value":"1","linkOpt":"and","builder":"equal"},{"name":"RWZTDM","linkOpt":"or","builder":"isNull"}]]''',
    '*order': '+KKDWDM,+KCH,+KXH',
    'pageSize': 1000,
    'pageNumber': ii}
    headers = {
```

```
        'user-agent': 'Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/91.0.4472.77 Safari/537.36',
        'cookie': cookie}
    # 课程接口
    rep = req.post('http://ehall.xjtu.edu.cn/jwapp/sys/kcbcx/modules/qxkcb/qxfbkccx.do', data=data,
                   headers=headers)
    content = rep.text
    # 生成一个字典
    content = json.loads(content)
    for i in range(len(content['datas']['qxfbkccx']['rows'])):
        teacher = content['datas']['qxfbkccx']['rows'][i]['SKJS']
        credit = content['datas']['qxfbkccx']['rows'][i]['KNZXS']
        cno = content['datas']['qxfbkccx']['rows'][i]['KCH']
        time = content['datas']['qxfbkccx']['rows'][i]['XNXQDM']
        name = content['datas']['qxfbkccx']['rows'][i]['KCM']
        period = content['datas']['qxfbkccx']['rows'][i]['XS']
        # 取出对应的数据
        dic['cno'] = cno
        dic['name'] = name
        dic['period'] = period
        dic['credit'] = credit
        dic['teacher'] = teacher
        dic['time'] = time
        if(teacher == None):
            strs = cno + "##" + name + "##" + str(period) + "##" + str(credit) + "##" + "Null" + '\n'
        else:
            strs = cno + "##" + name + "##" + str(period) + "##" + str(credit) + "##" + teacher + '\n'

        f.write(strs)

f.close()


```

4.3 JDBC生成数据 --- Java源码

getcourse.java

```
import java.io.*;
import java.util.*;

public class getcourse {
    static ArrayList<ArrayList<String>> course;
    static Set<String> cno;
    static HashMap<String,String> cno_new;
    static ArrayList<String> cno_list100;
    static ArrayList<String> cno_list1000;
    static ArrayList<String> insert100;
    static ArrayList<String> insert1000;
    private static void readFile1(File fin) throws IOException {
        course = new ArrayList<ArrayList<String>>();
        cno = new HashSet<String>();
        cno_new = new HashMap<String, String>();
```

```java
        insert100 = new ArrayList<String>();
        insert1000 = new ArrayList<String>();
        cno_list100 = new ArrayList<String>();
        cno_list1000 = new ArrayList<String>();
        FileInputStream fis = new FileInputStream(fin);
        //Construct BufferedReader from InputStreamReader
        BufferedReader br = new BufferedReader(new InputStreamReader(fis));
        String line = null;
        int x = 0, y = 0, z = 1;
        int i = 0;
        HashSet<String> cno_re = new HashSet<>();
        cno_re.add("CS-01");
        cno_re.add("CS-02");
        cno_re.add("CS-03");
        cno_re.add("CS-04");
        cno_re.add("CS-05");
        cno_re.add("EE-01");
        cno_re.add("EE-02");
        cno_re.add("EE-03");
        while ((line = br.readLine()) != null) {
            String[] a = line.split("##");
            ArrayList<String> tmp = new ArrayList<String>(Arrays.asList(a));
            course.add(tmp);
            if(cno.contains(a[0])){
            }
            else{
                Random rd = new Random();
                i ++;
                char a0 = (char)('A' + rd.nextInt(0,25));
                char a1 = (char)('A' + rd.nextInt(0,25));
                int number = rd.nextInt(1,6);
                while(cno_re.contains("" + a0 + a1 + "-0" + String.valueOf(number))){
                    a1 = (char)('A' + rd.nextInt(0,25));
                }
                cno_re.add("" + a0 + a1 + "-0" + String.valueOf(number));
                String NewString = "" + a0 + a1 + "-" + "0" + String.valueOf(number);
                String insert_sql = "insert into C575 values(\'" + NewString + "\',\'" + a[1] + "\'," + a[2] + "," + a[3] + ",\'" + a[4] + "\')";

                if(cno_list100.size() < 100){
                    cno_list100.add(NewString);
                    insert100.add(insert_sql);
                }
                if(cno_list1000.size() < 1000){
                    cno_list1000.add(NewString);
                    insert1000.add(insert_sql);
                }
                cno_new.put(a[0], NewString);
                System.out.println(insert_sql);
                x += (y + (z) / 6) / 26;
                y = (y + (z) / 6) % 26;
                z = (z) % 6 + 1;
            }

            cno.add(a[0]);

```

```java

            // System.out.println(a[0].substring(1,3));
        }
        br.close();
    }
    public static void go(){
        try {
            File f = new File("D:\\Project\\java_proj\\untitled\\src\\course.txt");
            readFile1(f);
        }catch (Exception ex){
            ex.printStackTrace();
        }
    }
    public static void main(String[] args){
        go();
    }
}
```

getStudent.java

```java
import javax.swing.*;
import java.awt.event.ActionEvent;
import java.io.BufferedReader;
import java.io.File;
import java.io.FileInputStream;
import java.io.InputStreamReader;
import java.util.ArrayList;
import java.util.HashSet;
import java.util.Random;

public class getStudent {
    static ArrayList<String> insert1000;
    static ArrayList<String> insert5000;
    static ArrayList<String> sno1000;
    static ArrayList<String> sno5000;
    static ArrayList<String> ming;
    static ArrayList<String> xing;
    static ArrayList<String> name;
    static ArrayList<String> sushe;
    static void getming(){
        try {
            ming = new ArrayList<String>();
            xing = new ArrayList<>();
            name = new ArrayList<String>();
            File file = new File("D:\\Project\\java_proj\\untitled\\src\\ming.txt");
            File file2 = new File("D:\\Project\\java_proj\\untitled\\src\\xing.txt");

            FileInputStream fis = new FileInputStream(file);
            BufferedReader br = new BufferedReader(new InputStreamReader(fis));
            String line = null;
            while ((line = br.readLine()) != null) {
                String[] a = line.split("、");
                for(int i = 0; i < a.length; i++)ming.add(a[i]);
```

```java
            }

            FileInputStream fis2 = new FileInputStream(file2);
            BufferedReader br2 = new BufferedReader(new InputStreamReader(fis2));
            line = null;
            while ((line = br2.readLine()) != null) {
                String[] a = line.split(",");
                for(int i = 0; i < a.length; i++)xing.add(a[i]);
            }

            for(int i = 0; i < ming.size(); i++){
                for(int j = 0; j < ming.size(); j++){
                    name.add(ming.get(i) + ming.get(j));
                }
            }
        }catch (Exception ex){
            ex.printStackTrace();
        }

    }
    static void getinsert1000(){
        sushe = new ArrayList<String>();
        insert1000 = new ArrayList<String>() ;
        sno1000 = new ArrayList<>();
        HashSet<Integer> sno_re = new HashSet<Integer>();
        for(int i = 0; i < 1000; i++){
            Random rd = new Random();

            int sno = 11000000 + rd.nextInt(1,100000);
            while(sno_re.contains(sno)){
                sno = 11000000 + rd.nextInt(1,100000);
            }
            sno_re.add(sno);
            sno1000.add(String.valueOf(sno));
            int first_name_index = rd.nextInt(0, xing.size() - 1);
            int last_name_index = rd.nextInt(0, ming.size() - 1);
            int last_name_index2 = rd.nextInt(0, ming.size() - 1);
            int ming1 = rd.nextInt(10);
            String sname = ming1 >= 4 ? xing.get(first_name_index) + ming.get(last_name_index) + ming.get(last_name_index2) : xing.get(first_name_index) + ming.get(last_name_index);

            Boolean west = rd.nextBoolean();
            String w = west ? "西" : "东";
            int dorm_no = rd.nextInt(20) + 1;
            int floor = rd.nextInt(6) + 1;
            int room = rd.nextInt(40) + 1;
            String room_str = room < 10 ? "0" + String.valueOf(room) : String.valueOf(room);
            String dorm = w + String.valueOf(dorm_no) + "舍" + String.valueOf(floor)  + room_str;
            //System.out.println(w + String.valueOf(dorm_no) + "舍" + String.valueOf(floor)  + room_str);
            String sex = west ? "男" : "女";
            int year = rd.nextInt(2000,2006);
            int mon = rd.nextInt(12) + 1;
            int day = rd.nextInt(28) + 1;
```

```java
            String date = String.valueOf(year) + "-" + String.valueOf(mon) + "-" + String.valueOf(day);
            int cm = rd.nextInt(50,90);
            String height =  "1." + String.valueOf(cm);
            String insert_sql = "insert into S575 values(\'" + String.valueOf(sno) + "\',\'" + sname + "\',\'" + sex + "\',\'" + date + "\'," + height + ",\'" + dorm + "\')";
            System.out.println(insert_sql);
            insert1000.add(insert_sql);
        }
    }
    static void getinsert5000(){
        insert5000 = new ArrayList<String>();
        sno5000 = new ArrayList<>();
        HashSet<Integer> sno_re = new HashSet<>();
        for(int i = 10000; i < 10000 + 5000; i++){
            Random rd = new Random();

            int sno = 10000000 + rd.nextInt(1,1000000);
            while(sno_re.contains(sno)){
                sno = 10000000 + rd.nextInt(1,1000000);
            }
            sno_re.add(sno);
            sno5000.add(String.valueOf(sno));

            int first_name_index = rd.nextInt(0, xing.size() - 1);
            int last_name_index = rd.nextInt(0, ming.size() - 1);
            int last_name_index2 = rd.nextInt(0, ming.size() - 1);
            int ming1 = rd.nextInt(10);
            String sname = ming1 >= 4 ? xing.get(first_name_index) + ming.get(last_name_index) + ming.get(last_name_index2) : xing.get(first_name_index) + ming.get(last_name_index);



            Boolean west = rd.nextBoolean();
            String w = west ? "西" : "东";
            int dorm_no = rd.nextInt(20) + 1;
            int floor = rd.nextInt(6) + 1;
            int room = rd.nextInt(40) + 1;
            String room_str = room < 10 ? "0" + String.valueOf(room) : String.valueOf(room);
            String dorm = w + String.valueOf(dorm_no) + "舍" + String.valueOf(floor)  + room_str;
            //System.out.println(w + String.valueOf(dorm_no) + "舍" + String.valueOf(floor)  + room_str);
            String sex = west ? "男" : "女";
            int year = rd.nextInt(2000,2006);
            int mon = rd.nextInt(12) + 1;
            int day = rd.nextInt(28) + 1;
            String date = String.valueOf(year) + "-" + String.valueOf(mon) + "-" + String.valueOf(day);
            int cm = rd.nextInt(50,90);
            String height =  "1." + String.valueOf(cm);
            String insert_sql = "insert into S575 values(\'" + String.valueOf(sno) + "\',\'" + sname + "\',\'" + sex + "\',\'" + date + "\'," + height + ",\'" + dorm + "\');";
            System.out.println(insert_sql);
```

```
            insert5000.add(insert_sql);

        }
    }
    public static void go(){
        getming();

        getinsert1000();
        getinsert5000();
    }
    public static void main(String[] args){
        go();
    }
}
```

getSC.java

```
import java.util.ArrayList;

public class getSC {
    static ArrayList<String[]> sc1;
    static ArrayList<String[]> sc2;
    static ArrayList<String> g;
    static ArrayList<String> g2;

    static ArrayList<String> insert_s;
    static ArrayList<String> insert_s2;
    static ArrayList<String> insert_c;
    static ArrayList<String> insert_c2;
    static ArrayList<String> insert_sc;
    static ArrayList<String> insert_sc2;
    public static void go(){
        getcourse gc = new getcourse();
        gc.go();
        ArrayList<String> cnoLis100 = gc.cno_list100;
        ArrayList<String> cnoLis1000 = gc.cno_list1000;
        //for(int i = 0; i < cnoLis.size(); i++)
System.out.println(cnoLis.get(i));
        //System.out.println(cnoLis1000.size());
        getStudent gs = new getStudent();
        gs.go();
        ArrayList<String> SnoLis1000 = gs.sno1000;
        ArrayList<String> SnoLis5000 = gs.sno5000;
        g = new ArrayList<>();
        g2 = new ArrayList<>();
        sc1 = new ArrayList<>();
        insert_c = gc.insert100;
        insert_c2 = gc.insert1000;
        insert_s = gs.insert1000;
        insert_s2 = gs.insert5000;
        insert_sc = new ArrayList<>();
        insert_sc2 = new ArrayList<>();

        for(int i = 0;i < 1000; i++){
            int rd = (i * i + 9) % 11;
            int k = 1;
            while(rd  < 100){
```

```java
                String[] tmp = {SnoLis1000.get(i), cnoLis100.get(rd)};
                sc1.add(tmp);
                rd += 11;
                double gd = Math.random() * 60 + 40;
                if((i * i * 7 + 2) % 4 == 0)gd = -1;
                String grade = gd == -1 ? "NULL" : String.format("%.2f",gd);
                g.add(grade);
                String insert_sql = "insert into sc575 values(\'" + tmp[0] + "\',\'" + tmp[1] + "\'," + grade + ")";
                System.out.println(insert_sql);
                insert_sc.add(insert_sql);

            }
        }
        sc2 = new ArrayList<>();
        System.out.println("yes");
        for(int i = 0;i < 5000; i++){
            int rd = (i * i + 9) % 101;
            int k = 1;
            while(rd < 1000){
                String[] tmp = {SnoLis5000.get(i), cnoLis1000.get(rd)};
                sc2.add(tmp);
                rd += 101;
                double gd = Math.random() * 60 + 40;
                if((i * i * 7 + 2) % 4 == 0)gd = -1;
                String grade = gd == -1 ? "NULL" : String.format("%.2f",gd);
                g2.add(grade);
                String insert_sql = "insert into sc575 values(\'" + tmp[0] + "\',\'" + tmp[1] + "\'," + (grade) + ");";

                insert_sc2.add(insert_sql);

            }
        }
        System.out.println(sc1.size());
        System.out.println(sc2.size());
    }
    public static void main(String[] args){
        go();

    }

}
```

4.4 JDBC连接数据库

openGauss.java

```java
import java.sql.*;
import java.util.ArrayList;
public class openGaussDemo {

    static final String JDBC_DRIVER = "org.postgresql.Driver";
    static final String DB_URL = "jdbc:postgresql://192.168.56.102:26000/mydb1?ApplicationName=app1";
    // 数据库的用户名与密码，需要根据自己的设置
    static final String USER = "my_root";
```

```java
    static final String PASS = "my_root@123";
    public static void main(String[] args) {
        Connection conn = null;
        Statement stmt = null;
        try{
            // 注册 JDBC 驱动
            Class.forName(JDBC_DRIVER);

            // 打开链接
            System.out.println("连接数据库...");
            conn = DriverManager.getConnection(DB_URL,USER,PASS);

            // 执行查询
            System.out.println(" 实例化Statement对象...");
            stmt = conn.createStatement();
            String sql;
            //sql = "SELECT * FROM s575";
            PreparedStatement ps = null;
            getSC gsc = new getSC();
            getSC.go();
            ArrayList<String> sql_s = gsc.insert_s;
            ArrayList<String> sql_c = gsc.insert_c;
            ArrayList<String> sql_sc = gsc.insert_sc;
            for(int i = 0; i < sql_s.size(); i++)stmt.execute(sql_s.get(i));
            for(int i = 0; i < sql_c.size(); i++)stmt.execute(sql_c.get(i));
            for(int i = 0; i < sql_sc.size(); i++)stmt.execute(sql_sc.get(i));
            //ResultSet rs = stmt.executeQuery(sql);
            // System.out.println(rs);
            // 展开结果集数据库
            /*
            while(rs.next()){
                // 通过字段检索
                int id  = rs.getInt("Sno");
                String name = rs.getString("SNAME");
                String url = rs.getString("DORM");

                // 输出数据
                System.out.print("ID: " + id);
                System.out.print(", 站点名称: " + name);
                System.out.print(", 站点 URL: " + url);
                System.out.print("\n");
            }*/
            // 完成后关闭
            //rs.close();
            stmt.close();
            conn.close();
        }catch(SQLException se){
            // 处理 JDBC 错误
            se.printStackTrace();
        }catch(Exception e){
            // 处理 Class.forName 错误
            e.printStackTrace();
        }finally{
            // 关闭资源
            try{
                if(stmt!=null) stmt.close();
            }catch(SQLException se2){
```

```
            }// 什么都不做
            try{
                if(conn!=null) conn.close();
            }catch(SQLException se){
                se.printStackTrace();
            }
        }
        System.out.println("Goodbye!");
    }
}
```