SQL Query

1. Relational Algebra

1.0. Overview

1️⃣关系操作

Operations	Notation	原关系	操作(得到新关系)
Projection	π	原关系	1.保留想要的列(竖直过滤) → 2.去除重复行
Selection	σ	原关系	保留想要的行(水平过滤) →
Union	$\cup$	原关系1+原关系2	1.合并两表所有Tuple → 2.去除重复项
Intersection	$\cap$	原关系1+原关系2	1.提取两个表都出现的Tuple → 2.去除重复项
Set-difference	$-$	原关系1+原关系2	移除关系2所含Tuple(在关系1中) →
Cross-product	$\times$	原关系1+原关系2	Tuple无条件互相组合(笛卡尔积) →
Join	$\bowtie$	原关系1+原关系2	1.Tuple无条件互相组合 → 2.按条件Selection

2️⃣Condition Expressions:

类型	符号
Arithmetic Expressions	`>, <, >=, <=, =, !=`
AND/OR Clauses	`AND = ∧, OR = V`

比如$\sigma_{\text{rating}\geq 9 \wedge \text{age}<50}(S_2)$

```
SELECT * FROM S2
WHERE rating >= 9 AND age < 50;
```

1.1. Projection(π) & Selection(σ)

1️⃣Projection(π)

1. 操作：仅保留Projection List中的列→ 去除重复的行
2. 特点：Projection is a costly operation, DB won't operate it by default.
3. 示例：

```sql
SELECT * FROM Student; -- 选中所有列(左表)
SELECT age FROM Student; -- 选中年龄这一列，但是SQL操作中默认不去除重复项(中表)
SELECT DISTINCT age FROM Student; -- 选中年龄这一列，删除重复项(右表)
```

sid	sname	rating	age
28	yuppy	9	35.0
31	lubber	8	55.5
44	guppy	5	35.0
58	rusty	10	35.0

$\pi_{\text{age}}(S)$ →

age
35.0
55.5
35.0
35.0

Removed duplicates →

age
35.0
55.5

2 Selection(σ)

1. 操作：仅保留Selection条件的行，并且不会有任何重复行
2. 示例：在SQL中体现在`WHERE`上

```sql
SELECT * FROM Student WHERE Student.rating >= 9;
```

sid	sname	rating	age
28	yuppy	9	35.0
~~31~~	~~lubber~~	~~8~~	~~55.5~~
~~44~~	~~guppy~~	~~5~~	~~35.0~~
58	rusty	10	35.0

$\sigma_{\text{rating}\geq 9}(S)$ →

sid	sname	rating	age
28	yuppy	9	35.0
58	rusty	10	35.0

3 Projection(π) & Selection(σ)组合示例

```sql
SELECT sname, rating FROM Student WHERE Student.rating >= 9;
```

~~sid~~	sname	rating	~~age~~
28	yuppy	9	35.0
~~31~~	~~lubber~~	~~8~~	~~55.5~~
~~44~~	~~guppy~~	~~5~~	~~35.0~~
58	rusty	10	35.0

$\pi_{\text{sname, rating}}(\sigma_{\text{rating}\geq 9}(S))$ →

sname	rating
yuppy	9
rusty	10

1.2. Union/Set-Difference/Intersection

对应的SQL操作叫做Set Operations

0 条件(Union-Compatible):

1. 两表要有相同的列，相应的列的数据类型相同
2. 该条件适用Union/Set Difference/Intersection三者

1 Union:

1. 操作：将两表和在一起，并消除重复项
2. 示例：注意操作有对称性；在SQL代码中体现在`UNION`上

```sql
SELECT sid, sname, rating, age FROM S1 -- 此操作去除重复行
UNION
SELECT sid, sname, rating, age FROM S2;
SELECT sid, sname, rating, age FROM S1 -- 此操作保留重复行
UNION ALL
SELECT sid, sname, rating, age FROM S2;
```

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

sid	sname	rating	age
28	yuppy	9	35.0
31	lubber	8	55.5
44	guppy	5	35.0
58	rusty	10	35.0

$\xrightarrow[\text{or } S_2 \cup S_1]{S_1 \cup S_2}$

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0
44	guppy	5	35.0
28	yuppy	9	35.0

2 Set-Difference:

1. 操作：从一个关系中，删除另一个关系中存在的Tuple
2. 示例：注意操作无对称性；SQL中并<mark>没有直接的求差集子句</mark>，可以通过子查询变相实现

```sql
SELECT sid, sname, rating, age
FROM S1
WHERE (sid, sname, rating, age) NOT IN (
    SELECT sid, sname, rating, age
    FROM S2
);
```

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

sid	sname	rating	age
28	yuppy	9	35.0
31	lubber	8	55.5
44	guppy	5	35.0
58	rusty	10	35.0

$\xrightarrow{S_1 - S_2}$

sid	sname	rating	age
22	dustin	7	45.0

3 Intersection

1. 操作：找出两个关系中共存的Tuples，本质上是混合运算$R \cap S = R - (R - S)$
2. 示例：注意操作有对称性；同样也需要用SQL子查询变相实现

```sql
SELECT sid, sname, rating, age
FROM S1
WHERE (sid, sname, rating, age) IN (
    SELECT sid, sname, rating, age
    FROM S2
);
```

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

sid	sname	rating	age
28	yuppy	9	35.0
31	lubber	8	55.5
44	guppy	5	35.0
58	rusty	10	35.0

$\xrightarrow[\text{or } S_2 \cap S_1]{S_1 \cap S_2}$

sid	sname	rating	age
31	lubber	8	55.5
58	rusty	10	35.0

1.3. Cross product & Joins

SQL Inter Table Operations

1.3.1. Cross Product($\times$)

1️⃣操作：用一个表的每行，依次去扫描另一个表的每一行，输出组合

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

sid	bid	day
22	101	10/10/96
58	103	11/12/96

$\xrightarrow{R \times S}$

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	22	101	10/10/96
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	22	101	10/10/96
31	lubber	8	55.5	58	103	11/12/96
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

2️⃣重命名ρ:

1. 合并后的属性名称可能一样，由此需要重命名
2. 比如$\rho(C(1 \to sid1, 5 \to sid2), R \times S)$

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	22	101	10/10/96
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	22	101	10/10/96
31	lubber	8	55.5	58	103	11/12/96
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

$\longrightarrow$

sid1	sname	rating	age	sid2	bid	day
22	dustin	7	45.0	22	101	10/10/96
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	22	101	10/10/96
31	lubber	8	55.5	58	103	11/12/96
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

3️⃣SQL代码

```
SELECT * FROM R, S;  -- Cross product between R, S
```

1.3.2. Inner Join($\bowtie$) : Conditional Cross-Product

1. Inner Join(AKA Condition Join): $R \bowtie_{Condition} S = \sigma_{Condition}(R \times S)$

   1. $R \bowtie_{(S.sid<R.sid)} S$中，先计算$R \times S$

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

sid	bid	day
22	101	10/10/96
58	103	11/12/96

$R \times S \longrightarrow$

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	22	101	10/10/96
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	22	101	10/10/96
31	lubber	8	55.5	58	103	11/12/96
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

   2. 再筛选满足(R.sid<S.sid)的行

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	22	101	10/10/96
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	22	101	10/10/96
31	lubber	8	55.5	58	103	11/12/96
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

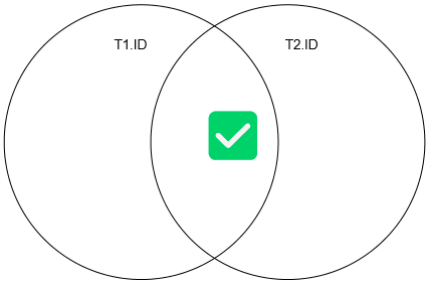
$\longrightarrow$

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	58	103	11/12/96

   3. SQL代码

```sql
SELECT * FROM R INNER JOIN S ON R.sid < S.sid;
```

2. Natural Join(AKA Join): 一种隐式的Inner Join



   1. 先计算$R \times S$，找到两表共同属性(此处为sid)

sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

sid	bid	day
22	101	10/10/96
58	103	11/12/96

$R \times S \longrightarrow$

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	22	101	10/10/96
22	dustin	7	45.0	58	103	11/12/96
31	lubber	8	55.5	22	101	10/10/96
31	lubber	8	55.5	58	103	11/12/96
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

2. 找出两共同属性值相同的行，将复合条件的行选出来，即$R \bowtie_{R.sid=S.sid} S$

(sid)	sname	rating	age	(sid)	bid	day
22	dustin	7	45.0	22	101	10/10/96
~~22~~	~~dustin~~	~~7~~	~~45.0~~	~~58~~	~~103~~	~~11/12/96~~
~~31~~	~~lubber~~	~~8~~	~~55.5~~	~~22~~	~~101~~	~~10/10/96~~
~~31~~	~~lubber~~	~~8~~	~~55.5~~	~~58~~	~~103~~	~~11/12/96~~
58	rusty	10	35.0	22	101	10/10/96
58	rusty	10	35.0	58	103	11/12/96

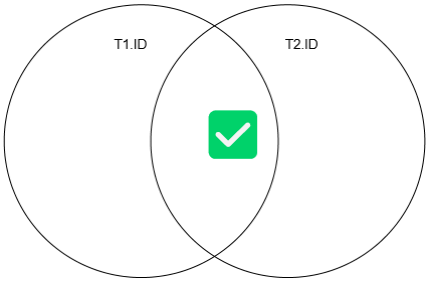
$R \bowtie S$ ⟶

sid	sname	rating	age	bid	day
22	dustin	7	45.0	101	10/10/96
58	rusty	10	35.0	103	11/12/96

3. SQL代码

```
SELECT * FROM R NATURAL JOIN S
```

3️⃣ Equi Join: 一种Inner Join的特殊情况，比如$R \bowtie_{(S_1.sid=R_2.sid)} S$(条件是等式)



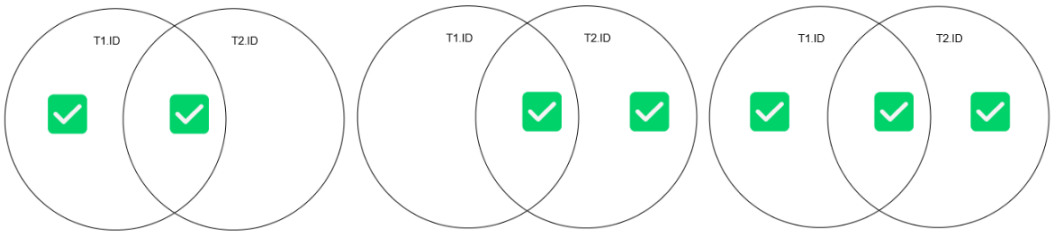

```
SELECT * FROM R INNER JOIN S ON R.sid = S.sid;
```

1.3.3. Outer Join : Include Every Record

1️⃣ 概述

Outer Join	**操作**
Left Outer Join	保留左表中所有记录，右表中不匹配的用NULL代替
Right Outer Join	保留右表中所有记录，左表中不匹配的用NULL代替
Full Outer Join	保留左右两表中所有记录，两表中不匹配的用NULL代替

2️⃣ 示意图：Left/Right/Full



3️⃣ 示例

客户表	CID	属性1	属性2	账户表	CID	AID	属性3
\	1	X1	Y1	\	1	1	Z1
\	2	X2	Y2	\	1	2	Z2
\	3	X3	Y3	\	2	3	Z3
\	\	\	\	\	4	4	Z4

1. Left Outer Join: `Customer.CustomerID = 3`时有表无匹配，所以代之以NULL

```
SELECT * FROM Customer LEFT OUTER JOIN Account
ON Customer.CustomerID = Account.CustomerID; -- 左外联，保留左表所有
CustomerID
```

CID	属性1	属性2	AID	属性3
1	X1	Y1	1	Z1
1	X1	Y1	2	Z2
2	X2	Y2	3	Z3
3	X3	Y3	NULL	NULL

2. Right Outer Join: `Account.CustomerID = 4`时有表无匹配，所以代之以NULL

```
SELECT * FROM Customer RIGHT OUTER JOIN Account
ON Customer.CustomerID = Account.CustomerID; -- 右外联，保留右表所有
CustomerID
```

CID	属性1	属性2	AID	属性3
1	X1	Y1	1	Z1
1	X1	Y1	2	Z2
2	X2	Y2	3	Z3
4	NULL	NULL	4	Z4

3. Full Outer Join: 也可以认为是Right Outer Join结果 ∪ Leftt Outer Join结果

```
SELECT * FROM Customer FULL OUTER JOIN Account
ON Customer.CustomerID = Account.CustomerID; -- 全外联，保留两表所有
CustomerID
```

D	属性 I	属性 S	D	属性 3
1	X1	Y1	1	Z1
1	X1	Y1	2	Z2

CID	属性1	属性2	AID	属性3
2	X2	Y2	3	Z3
3	X3	Y3	NULL	NULL
4	NULL	NULL	4	Z4

1.3.4. 复合Join

1️⃣示例的ABC表格

A	AID	AName	B	BID	AID	BName	C	CID	CType	BName
\	1	`AName1`	\	101	1	`BName1`	\	1001	`CType1`	`BName2`
\	2	`AName2`	\	102	1	`BName2`	\	1002	`CType2`	`BName3`
\	\	\	\	201	2	`BName3`	\	\	\	\

2️⃣Inner Join

```
A INNER JOIN B ON A.AID = B.AID
```

A.AID	A.AName	B.ID	B.AID	B.BName
1	`AName1`	101	1	`BName1`
1	`AName1`	102	1	`BName2`
2	`AName2`	201	2	`BName3`

2️⃣复合Inner Join: 拿上面那个Join的结果再去Join

```
A INNER JOIN B ON A.AID = B.AID INNER JOIN C ON B.BName = C.BName
```

A.AID	A.AName	B.ID	B.AID	B.BName	C.CID	C.CType	C.BName
1	`AName1`	101	1	`BName2`	1001	`CType1`	`BName2`
2	`AName2`	201	2	`BName3`	1002	`CType2`	`BName3`

2. SQL Overview

2.0. CRUD Commends

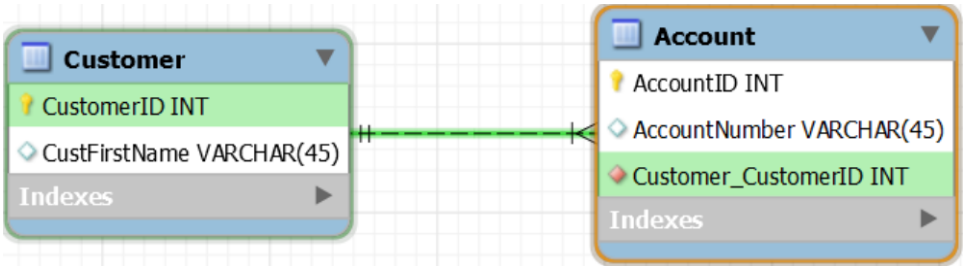
Create/Read/Update/Delete Commands

缩写	功能	说明
DDL	Definition	定义并建立数据库
DML	Manipulation	维护并使用(查询)数据库，获取数据的价值与信息

Command Type	功能	Description
DCL	Control	控制用户对数据的访问权
Other	N/A	管理数据库

2.1. DDL Commands

1️⃣创建表格操作`CREAT`，其实也就是Implementation操作




```
-- 创建Customer表
CREATE TABLE Customer (
CustomerID INT PRIMARY KEY,
CustFirstName VARCHAR(45)
);
-- 创建Account表
CREATE TABLE Account (
-- 若表中现有最后一行ID是1001，插入的新ID自动变成1002
AccountID INT AUTO_INCREMENT PRIMARY KEY,
-- 枚举数据类型，只允许账户号码为三者之一
AccountNumber ENUM('Num1', 'Num2', 'Num3');
Customer_CustomerID INT,
FOREIGN KEY (Customer_CustomerID) REFERENCES Customer(CustomerID)
);
```

1. 关于Key
    - 要用`PRIMARY KEY`指定哪个变量时主键
    - 要用`FOREIGN KEY REFERENCES`指定Foreign Key引用的哪个变量，否则会Syntax Error
2. 补充事项
    - `AUTO_INCREMENT`: 用来标记主键字段，插入一个记录后被标记字段自动+1
    - `ENUM`: 枚举数据类型类型，只允许属性为预设值

2️⃣修改表格系列操作

1. 增减表格的Attributes: `ALTER`

```
-- 客户表中添加CustLastName属性
ALTER TABLE Customer ADD CustLastName VARCHAR(45);
-- 账户表中删除AccountNumber属性
ALTER TABLE Account DROP AccountNumber;
```

2. 表格重命名: `RENAME`

```
RENAME TABLE Customer TO NewCustomers -- 将Customer表重命名为
NewCustomers
```

3. 清空表中的所有记录: `TRUNCATE`

```
TRUNCATE TABLE Customer -- 清空所有客户的数据，快速方式但不能回退(Roll Back)
DELETE * FROM  Customer -- 清空所有客户的数据，慢速方式且可以回退
```

4. 彻底删除(杀死)一个表格: `DROP`

```
DROP TABLE Customer -- 把客户表的数据，以及客户表，都根除
```

3️⃣ 查看表格操作: `VIEW` 视图，只是一种虚拟表(不存储在内存中)

```
-- 创建虚拟表格CustomerAccountView视图
CREATE VIEW CustomerAccountView AS
SELECT Customer.CustomerID, Account.AccountNumber
FROM Customer JOIN Account
ON Customer.CustomerID = Account.Customer_CustomerID;

-- 通过视图来查询数据，就像查询普通表格一样，简化了查询
SELECT * FROM CustomerAccountView;
```

2.2. DCL & Other Commands

1️⃣ DCL用户与权限

1. 创建/删除用户: `CREATE USER/DROP USER`

```
-- 创建用户，初始密码为123
CREATE USER 'john'@'localhost' IDENTIFIED BY '123';
-- 删除john用户
DROP USER 'john'@'localhost';
```

2. 分配/撤销用户权限: `GRANT / REVOKE`

```
-- 授予john在mydatabase数据库Table1表的SELECT和INSERT权限
GRANT SELECT,INSERT ON mydatabase.Table1 TO 'john'@'localhost';
-- 撤销john在mydatabase数据库Table1表的INSERT权限
REVOKE INSERT ON mydatabase.Table1 FROM 'john'@'localhost';
```

3. 设置密码: `SET PASSWORD`

```
-- 设置新密码为0123
SET PASSWORD FOR 'john'@'localhost' = PASSWORD('0123');
```

2️⃣ Database Administration

1. 意外删除的恢复: `BACKUP TABLE/RESTORE TABLE`(二者其实并非标准SQL命令)
2. 展示表格模式(Scheme)

```
CREATE TABLE Customer (
    CustomerID INT AUTO_INCREMENT PRIMARY KEY,
    CustFirstName VARCHAR(45),
    DateOfBirth DATE
);
-- 查看Customer表的结构，结果如下表
DESCRIBE Customer
```

Field	Type	Null	Key	Default	Extra
CustomerID	INT	NO	PRI	NULL	auto_increment
CustFirstName	VARCHAR(45)	YES		NULL	
DateOfBirth	DATE	YES		NULL	

3. `USE <db_name>`: 挑选进入哪个数据库来操作

2.3. Tips About SQL

1️⃣SQL的属性名大小/关键词写不敏感，但一般大写。如下两段查询含义相同

```
SELECT * FROM Furniture WHERE
(Type = 'Chair' AND Colour = 'Black') OR (Type = 'Lamp' AND Colour =
'Black');
select * from furniture where
(type = 'Chair' and colour = 'Black') or (type = 'Lamp' and colour =
'Black');
```

3️⃣SQL的表名在Linux上区分大小写，但Windows上又不区分

3. SQL Core: DML Commands

3.1. 变更表中内容

3.1.1. Insert Data: `Insert Into`

0️⃣示例表格

CustID	FirstName	MiddleName	LastName	BusinessName	CustType
1	Peter	NULL	Smith	NULL	Personal
2	James	NULL	Jones	JJ	Company
3	NULL	NULL	Smythe	NULL	Company

1️⃣显式插入：指名要给哪几个属性插入数据

```
-- 一次性可以插入一条数据
INSERT INTO Customer (FirstName, LastName, CustType) VALUES
("Peter", "Smith", 'Personal');

-- 也可以多条
INSERT INTO Customer (FirstName, LastName, CustType) VALUES
("Peter" , "Smith" , 'Personal'),
("Jamnes", "Jones" , 'Company' ),
(""      , "Smythe", 'Company' );
```

2️⃣ 隐式插入：省略具体的属性，将提供的值按顺序依次插入属性

```
-- 插入第一条数据，DEFAULT子句会让CustID从0开始自动+1(此处+1后CustID=1)
INSERT INTO Customer VALUES
(DEFAULT, "Peter", "", "Smith", "", 'Personal');

-- 一次性插入多条数据
INSERT INTO Customer VALUES
(DEFAULT, "Peter", ""  , "Smith" , ""  , 'Personal');
(DEFAULT, "James", NULL, "Jones" , "JJ", 'Company' );
(DEFAULT, ""     , NULL, "Smythe", ""  , 'Company' );
```

3️⃣ 从其他表格插入数据

```
-- 将所有Customer中的记录，全部插入NewCustomer中
INSERT INTO NewCustomer SELECT * FROM Customer;
```

🐸 `REPLACE`和`INSERT`功能几乎一致，区别仅仅在于，当待插入记录的PK $\overset{\text{相同}}{\longleftrightarrow}{}_{\text{冲突}}$已存在记录的PK

1. `INSERT`：操作费费，插入失败
2. `REPLACE`：操作合法，并且待插入记录覆盖冲突的已存在记录

3.1.2. Changes Existing Data: `UPDATESET` 结构

1️⃣ `UPDATE` 示例

```
-- Block1: 所有薪水小于100000的涨薪5%
UPDATE Salaried SET AnnualSalary = AnnualSalary * 1.05
WHERE AnnualSalary <= 100000;
-- Block2: 所有薪水大于100000的涨薪10%
UPDATE Salaried SET AnnualSalary = AnnualSalary * 1.10
WHERE AnnualSalary > 100000;
```

1. 子句执行的顺序会影响结果
2. 没有`WHERE`子句时，更新会应用到表格的每一行

2️⃣ `CASE` Command优化示例

```sql
UPDATE Salaried SET AnnualSalary =
CASE
    WHEN AnnualSalary <= 100000 THEN AnnualSalary * 1.05
    ELSE AnnualSalary * 1.10
END;
```

3.1.3. Deleting Existing Data: `DELETE`

1️⃣简答例子

```sql
-- 删除表中所有记录，危险操作
DELETE FROM Employee
-- 删除表中满足条件的操作
DELETE FROM Employee WHERE Name = "Grace"
```

2️⃣删除的外键约束

约束子句	尝试操作	执行操作
`ON DELETE CASCADE`	A表尝试删除一行	操作总被允许，引用该行的B表行都删除
`ON DELETE RESTRICT`	A表尝试删除一行	如果改行被B表引用，则删除操作被禁止

```sql
CREATE TABLE B (
   Bid INT PRIMARY KEY,
   Bname VARCHAR(50),
   Aid INT,
   FOREIGN KEY (Aid) REFERENCES A(Aid) ON DELETE CASCADE
   FOREIGN KEY (Aid) REFERENCES A(Aid) ON DELETE RESTRICT  -- 二选一
);
```

3.2. 查询表中内容: `SELECT FROM + XXX`

3.2.1. `SELECT`有关结构

1️⃣最基本结构：投影，原理详见关系代数

```sql
SELECT * FROM Student; -- 选中所有列
SELECT age FROM Student; -- 选中年龄这一列，但是SQL操作中默认不去除重复项
SELECT DISTINCT age FROM Student; -- 选中年龄这一列，删除重复项
```

2️⃣聚合函数Aggregare Function

1. 概述

函数	功能
`AVG()`	Average Value
`MIN()`	Minimum Value

Function	Description
`MAX()`	Maximum Value
`COUNT()`	Number of Values(行数)
`SUM()`	Sum of Values

2. 示例

```
SELECT COUNT(CustomerID) FROM Customer; -- 有所少个CustomerID
SELECT AVG(Balance) FROM Account;       -- 所有账户余额的平均
SELECT MAX(Balance) FROM Account WHERE CustomerID=1;  -- 用户1的最高账户余额
SELECT SUM(Balance) FROM Account GROUP BY CustomerID; -- 各个用户的账户总余额
```

3. `SUM()`补充：
    - 当用于数值类型属性时，会遍历每行求出并返回总和
    - 当用于布尔类型属性时，会遍历每行(布尔真=1/布尔假=0)，返回总和

3️⃣重命名子句`AS` Clause

```
SELECT CustType, COUNT(CustomerID) FROM Customer -- 不重命名
SELECT CustType, COUNT(CustomerID) AS Count FROM Customer -- 重命名为Count
```

不重命名	CustType	Count(CustomerID)	重命名	CustType	Count
\	Type1	3	\	Type1	3
\	Type2	6	\	Type2	6

3.2.2. `FROM`有关结构

1️⃣最基本功能：选定要操作的表格

```
SELECT * FROM R
```

2️⃣跨表格操作：Cross-Product/Join，原理详见关系代数部分

1. Cross-Product

```
SELECT * FROM R, S;  -- Cross product between R, S
```

2. Join

```
SELECT * FROM R NATURAL JOIN S -- Nature Join

SELECT * FROM R INNER JOIN S ON R.sid < S.sid; -- Inner Join
SELECT * FROM R INNER JOIN S ON R.sid = S.sid; -- Equi Join

SELECT * FROM R LEFT OUTER JOIN S ON R.sid = S.sid;  -- Left Outer
Join
SELECT * FROM R RIGHT OUTER JOIN S ON R.sid = S.sid; -- Right Outer
Join
SELECT * FROM R FULL OUTER JOIN S ON R.sid = S.sid;  -- Full Outer
Join
```

3.2.3. +XXX有关结构

3.2.3.1. WHERE 有关结构

1 `WHERE` Clause: 本是上是一种Selection操作，过滤满足条件

```
SELECT * FROM Student WHERE Student.rating >= 9;
```

2 `LIKE` Clause: 与`WHERE`配合使用，实现字符串的匹配

Clause	`CustomerName` Maches	示例
`WHERE CustomerName LIKE 'a%'`	以a开始的	`axxxxx`
`WHERE CustomerName LIKE '%a'`	以a结束的	`xxxxxa`
`WHERE CustomerName LIKE '%a%'`	包含a的	`xxaxxx`
`WHERE CustomerName LIKE '_a%'`	a在第二位的	`xaxxxx`
`WHERE CustomerName LIKE 'a_%_%'`	以a开始，并且后面至少两字符	`axx/axxx`
`WHERE CustomerName LIKE 'a%o'`	以a开始o结尾	`axxxxo`

```
SELECT CustLastName FROM Customer WHERE CustLastName LIKE "Sm%"
-- 匹配的会有Smith/Smyth/Smize.......
```

3.2.3.2. GROUP BY有关结构

1 `GROUP BY` Clause:

1. 讲记录根据一个/多个属性，分为若干小组
2. 通常和聚合函数结合使用，为每个小组计算出独立结果
3. 示例

```
SELECT CustID, AVG(Balance) AS AveBalance
FROM Account
GROUP BY CustID;
```

原表	CustID	Account	Balance	查询结果	CustID	AveBalance
\	1	101	500	\	1	325
\	1	102	150	\	2	250
\	2	103	200	\	3	450
\	2	104	300	\	\	\
\	3	105	450	\	\	\

2️⃣ `HAVING` Clause

1. 作为`GROUP BY`+聚合函数的补充，用于对`GROUP BY`筛选出来的组
2. 示例：注意区分`WHERE`和`HAVING`
   - `WHERE <条件表达式>`：直接过滤原始的数据(过滤数据)

     ```
     SELECT OrderID, Amount FROM Orders WHERE Amount > 100;
     ```

   - `HAVING <条件表达式>`：对分组的结果进行过滤(过滤组)

查询结果	CustID	AveBalance	HAVING后	CustID	AveBalance
\	1	325	\	1	325
\	2	250	\	3	450
\	3	450	\	\	\

     ```
     SELECT CustID, AVG(Balance) AS AveBalance FROM Account
     GROUP BY CustID HAVING AveBalance > 300;
     ```

3.2.3.3. `ORDER BY` 有关结构

1️⃣ `ORDER BY` Clause:

1. 将查询得到的结果按照某一属性排序

   ```
   SELECT Name, Type FROM Customer ORDER BY Name; -- 按名字(字典序)默认升序
   SELECT Name, Type FROM Customer ORDER BY Name ASC;  -- 升序
   SELECT Name, Type FROM Customer ORDER BY Name DESC; -- 降序
   ```

2. 将查询得到的结果按照符合属性排序

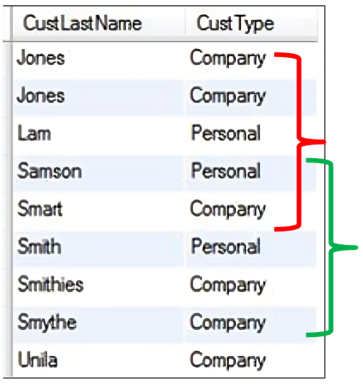
```
SELECT Name, Type FROM Customer
ORDER BY Name DESC, Type ASC;
 -- 先按Name降序排序
 -- 再对于Name相同的Tuple，按照Type升序排序
```

2️⃣ `LIMIT/OFFSET` Clause:

1. 含义

Clause	功能
`LIMIT N`	选取排序结果的前N个
`LIMIT N OFFSET M`	跳过排序结果的前N个，依次选取后面的M个

2. 示例:



CustLastName	CustType
Jones	Company
Jones	Company
Lam	Personal
Samson	Personal
Smart	Company
Smith	Personal
Smithies	Company
Smythe	Company
Unila	Company

```
SELECT Name, Type FROM Customer ORDER BY Name LIMIT 5; -- 红色
SELECT Name, Type FROM Customer ORDER BY Name LIMIT 5 OFFSET 3;
-- 绿色
```

3.3. 查询表中内容: Subquery

3.3.1. Subquery结构

0️⃣ 概述

1. `SELECT`结构相当于一个查询，在一个`SELECT`中插入另一个`SELECT`，则后者就是前者子查询
2. 执行顺序：先执行子查询→ 将子查询结果传给主查询→ 执行主查询
3. 相关子查询：子查询可以直接使用主(外层)查询的列/值

1️⃣ 在`SELECT`字句中插入子查询，一般使用`AS`重命名子查询返回的列

```
SELECT
    name,
    (SELECT COUNT(*) FROM orders) AS order_count
FROM customers;
```

2️⃣ 在`FROM`字句中插入子查询，子查询此时相当于一个临时表，所以必须使用`AS`重命名

```sql
SELECT tmp.average_sales
FROM  (SELECT AVG(amount) AS average_sales FROM sales) AS tmp;
```

3️⃣ 在`WHERE`子句中

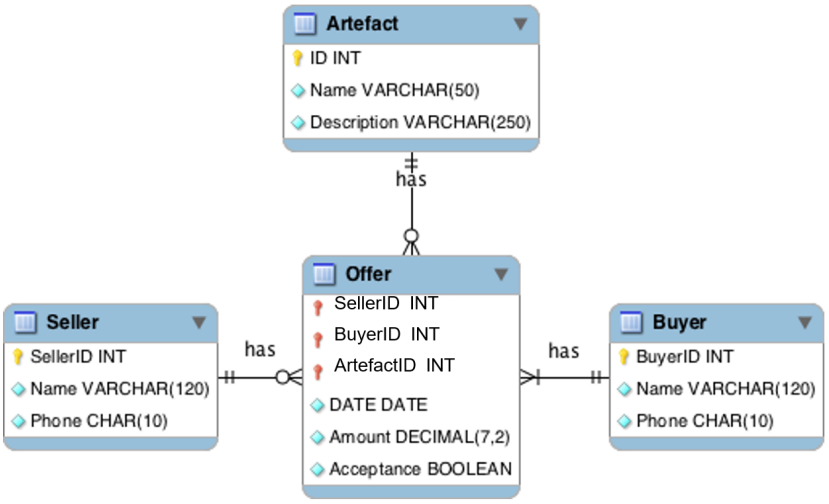
```sql
SELECT name, age
FROM employees
WHERE salary > (SELECT AVG(salary) FROM employees);
```

4️⃣ 在`EXISTS`中，返回布尔值的特殊类子查询

```sql
SELECT name
FROM products
WHERE EXISTS (SELECT 1 FROM inventory WHERE inventory.quantity > 0);
```

3.3.2. Subquery有关子句

0️⃣ 示例表格



1. Artefact/Seller/Buyer表

AID	Name	Descript	/	SID	Name	Phone	/	BID	Name	Phone
1	Vase	Old Vase	/	1	Abby	0232	/	1	Magg	0333
2	Knife	Old Knife	/	2	Ben	0311	/	2	Nicole	0444
3	Pot	Old Pot	/	3	Carl	0333	/	3	Oleg	0555

2. Offer表

AID	SID	BID	Date	Amount	Acceptance
1	1	1	2012-06-20	81223.23	N
1	1	2	2012-06-20	82223.23	N
1	2	1	2012-06-20	19.95	N
2	2	2	2012-06-20	23.00	N

1️⃣ `IN/NOT IN` Clause: 记录是否在子查询的结果中

```
SELECT * FROM Buyer
WHERE BID IN
(SELECT BID FROM Offer WHERE AID = 1)
```

1. 子查询结果：`BuyerID = 1/2`，主查询结果

BID	Name	Phone
1	Magg	0333
2	Nicole	0444

2. 基于Join的优化：执行的效率会更高

```
ELECT Buyer.*
FROM Buyer JOIN Offer ON Buyer.BID = Offer.BID
WHERE Offer.AID = 1;
```

2️⃣ `ANY/ALL/EXISTS`

1. `ANY`：满足至少一个内部条件

```
SELECT empno, sal FROM emp
WHERE sal > ANY (200, 300, 400);

-- equals to
SELECT empno, sal FROM emp
WHERE sal > 200 OR sal > 300 OR sal> 400;
```

2. `ALL`：满足所有内部条件

```
SELECT empno, sal FROM emp
WHERE sal > ALL (200, 300, 400);

-- equals to
SELECT empno, sal FROM emp
WHERE sal > 200 AND sal > 300 AND sal> 400;
```

3️⃣. `EXISIS`：内部查询至少返回一个结果

```
SELECT * FROM Buyer WHERE EXISTS(
   SELECT * FROM Offer
   WHERE Buyer.BuyerID = Offer.BuyerID
   AND ArtefactID = 1
)
```

1. 先遍历`Buyer`的每一行
2. 对于`Buyer`表的每一行，进入`Offer`表查询是否有行满足

```
Buyer.BuyerID = Offer.BuyerID AND ArtefactID = 1
```

3. 如果某行条件满足，则内部查询返回这一行，外部条件保留这一行，最后全部返回(如下)

BID	Name	Phone
1	Magg	0333
2	Nicole	0444

3.4. 其他SQL子句

1️⃣ `COALESCE()`: 返回列表中第一个非NULL值

```
-- 遍历每一行，如果A2非空则返回A2，如果A2空则返回''(首个非空值)
SELECT A1, COALESCE(A2, '') AS A2New, A3 FROM users;
```

初始表格	A1	A2	A3	查询结果	A1	A2New	A3
\	John	NULL	Doe	\	John		Doe
\	Jane	A.	Smith	\	Jane	A.	Smith
\	Emily	NULL	Davis	\	Emily		Davis

2️⃣ `LENGTH()`: 求出一段字符串的长度

```
ORDER BY LENGTH(Steing)      -- String长度从小到大排列
ORDER BY LENGTH(Steing) ASC  -- String长度从小到大排列
ORDER BY LENGTH(Steing) DEC  -- String长度从大到小排列
```

3️⃣ `CASE WHEN`语法

1. 语法

```
CASE WHEN <条件表达式> THEN <条件满足时返回这个值> <条件不满足时返回这个值>
END
```

2. 不重命名示例

```
SELECT
   id,
   amount,
   CASE WHEN amount > 100 THEN 'High' ELSE 'Low' END
   CASE WHEN amount > 100 THEN 'High' ELSE 'Low' END AS class -- 重命名
FROM orders;
```

不重命名	id	CASE	amount	重命名	id	CASE	class
\	1	High	150	\	1	High	150

不重命名	id	CASE	amount	重命名	id	CASE	class
\	2	Low	80	\	2	Low	80
\	3	High	120	\	3	High	120

4️⃣ Set Operation: 目的是合并两个查询结果，原理详见关系代数

```
SELECT sid, sname, rating, age FROM S1 -- 此操作去除重复行
UNION
SELECT sid, sname, rating, age FROM S2;
SELECT sid, sname, rating, age FROM S1 -- 此操作保留重复行
UNION ALL
SELECT sid, sname, rating, age FROM S2;
```