Database System

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Chapter 3-Contents

3.4 Data Modification Statements

3.4.1 INSERT statement

(1) INSERT INTO … VALUES

INSERT INTO TableName [(columnList)]
VALUES (dataValueList)

- **Insert a new tuple into the table.**
- ***columnList* is optional; if omitted, SQL assumes a list of all columns in their original CREATE TABLE order.**
- **Any columns omitted must have been declared as NULL when table was created, unless DEFAULT was specified when creating column.**

INSERT

INSERT INTO TableName [(columnList)]
VALUES (dataValueList)

dataValueList **must match** ***columnList*** **as follows:**

- **The number of items in each list must be same;**
- **data type of each item in *dataValueList* must be compatible with data type of corresponding column;**
- **It must be direct correspondence in position of items in two lists.**

Example 3.41 INSERT … VALUES

Insert a new row into Staff table supplying data for all columns.

Staff (staffNo, fName, lName, position,
sex, DOB, salary, branchNo)

```
INSERT INTO Staff
VALUES ('SG16', 'Alan', 'Brown', 'Assistant',
        'M', Date'1957-05-25', 8300, 'B003');
```

Example 3.41 INSERT using Defaults

Insert a new row into Staff table supplying data for all mandatory columns.

Staff (staffNo, fName, lName, position, sex, DOB, salary, branchNo)

```
INSERT INTO Staff (staffNo, fName, lName,
                   position, salary, branchNo)
VALUES (  'SG44', 'Anne', 'Jones',
          'Assistant', 8100, 'B003');
```

- **Or**

```
INSERT INTO Staff
VALUES ('SG44', 'Anne', 'Jones', 'Assistant',
        NULL, NULL, 8100, 'B003');
```

(2) INSERT … SELECT

The second form of INSERT allows multiple rows to be copied from the query result of one or more tables to another:

```
INSERT INTO TableName [ (columnList) ]
SELECT ...
```

Example 3.42 INSERT … SELECT

Assume there is a table StaffPropCount that contains names of staff and the number of properties they manage:

StaffPropCount (staffNo, fName, lName, propCnt)

Populate StaffPropCount using Staff and Property tables.

Example 3.42 INSERT … SELECT

```
INSERT INTO StaffPropCount
  ( SELECT s.staffNo, fName, lName, COUNT(*)
    FROM Staff s, Property  p
    WHERE s.staffNo = p.staffNo
    GROUP BY s.staffNo, fName, lName )

UNION

  ( SELECT staffNo, fName, lName, 0
    FROM Staff
    WHERE staffNo NOT IN
       ( SELECT DISTINCT staffNo
         FROM Property )
  );
```

Example 3.42 INSERT … SELECT

staffNo	fName	lName	propCount
SG14	David	Ford	1
SL21	John	White	0
SG37	Ann	Beech	2
SA9	Mary	Howe	1
SG5	Susan	Brand	0
SL41	Julie	Lee	1

If the second part of UNION is omitted, excludes those staff who currently do not manage any properties.

Example 3.43 **Find the students who did not pass an exam. Insert the student numbers, names, course numbers and grade into an existing table named NoPass(sno ,sn ,cno,g).**

```
insert into NoPass
select  s.sno , sn , cno, g
from    s , sc
where g <60 and  s.Sno =sc.Sno;
```

3.4.2 UPDATE statement

```
UPDATE TableName
SET columnName1 = dataValue1
    [, columnName2 = dataValue2...]
[WHERE searchCondition]
```

- ***TableName*** **can be the name of a base table or an updatable view.**
- **SET clause specifies the names of one or more columns that are to be updated.**

UPDATE

- **WHERE clause is optional:**
  - **if omitted, named columns are updated for all rows in table;**
  - **if specified, only those rows that satisfy *searchCondition* are updated.**
- **New *dataValue(s)* must be compatible with data type for corresponding column.**

Example 3.44/45 UPDATE All Rows

(1) Give all staff a 3% pay increase.

```
UPDATE Staff
SET salary = salary*1.03;
```

(2) Give all Managers a 5% pay increase.

```
UPDATE Staff
SET salary = salary*1.05
WHERE position = 'Manager';
```

Example 3.46 UPDATE Selected Rows

(3) Give all staff who work in London a 3% pay increase.

```
UPDATE   Staff
SET   salary = salary*1.03
WHERE   branchNo in
                ( SELECT  branchNo
                  FROM Branch
                  WHERE city = 'London');
```

```
UPDATE Staff , Branch
SET salary = salary*1.03
WHERE Staff.branchNo =Branch.branchNo
      and city = 'London';
```

Wrong !

Example 3.47 UPDATE Multiple Columns

Promote David Ford (staffNo='SG14') to Manager and change his salary to £18,000.

```
UPDATE Staff
SET position = 'Manager',
      salary = 18000
WHERE staffNo = 'SG14';
```

Example 3.48 UPDATE in SQL Server

Set the grade to null, which is less than 60 for course ‘Data Structure’.

```
UPDATE sc
SET grade = NULL
FROM sc, course
WHERE sc.cno = course.cno
    AND grade <60
    AND course.cname = 'Data Structure'
```

```
Update sc
set grade = null
Where grade <60 and cno in
      ( select cno from course
        where cname='Data Structure')
```

Example 3.49 **Cancel the grade of student *s1*'s course *c1*.**

```
UPDATE SC
SET grade=null
WHERE sno = 's1' and cno='c1';
```

注意'='的用法，set后不能用 'is null'，where后不能用 '=null'

Example 3.50 **Increase the grades of course C2 which is not null by 10%.**

```
UPDATE SC
SET grade=grade*1.1
WHERE cno='c2'
```

OK !

3.4.3 DELETE Statement

DELETE FROM TableName

[WHERE searchCondition]

- ***TableName*** **can be the name of a base table or an updatable view.**
- ***searchCondition*** **is optional; if omitted, all rows are deleted from table.**
- **If *searchCondition* is specified, only those rows that satisfy condition are deleted.**
- **This does not delete table definition.**
- **If we want to delete a column value in all rows, could write UPDATE s SET sex=null**

Example 3.51/52 DELETE Specific Rows

(1) Delete all viewings that relate to property PG4.

```
DELETE FROM Viewing
WHERE propertyNo = 'PG4';
```

(2) Delete all records from the Viewing table.

```
DELETE FROM Viewing;
```

Example 3.53 DELETE Specific Rows

Delete all course records of all female students.

```
DELETE FROM sc
WHERE sno IN ( SELECT sno
               FROM s
               WHERE sex='F' ) ;
```

```
DELETE FROM sc, s
WHERE s.sno =sc.sno  and sex= 'F'
```

Wrong !

```
DELETE sc FROM s, sc
where sc.sno=s.sno  and sname='张三'
```

SQL Server Correct !

Example 3.54 Remove all tuples in both table sc and s which are involved with student ‘s8’.

```
DELETE FROM  sc
WHERE sno='s8';

DELETE FROM  s
WHERE sno='s8';
```

3.5 Views

3.5.1 Definition of View

It is a Dynamic result of one or more relational operations operating on base relations to produce another relation.

- Virtual relation: Its data does not necessarily actually exist in the database, only its definition is kept in DD.
- It is produced upon request, at time of request.

Views

- **Contents of a view are defined as a query on one or more base relations.**
- **With <u>view resolution</u>, any operations on view are automatically translated into operations on relations from which it is derived.**
- **With <u>view materialization</u>, the view is stored as a temporary table, which is maintained as the underlying base tables are updated.**

SQL - CREATE VIEW

CREATE VIEW ViewName

[(newColumnName [,...])]

AS subselect

[WITH CHECK OPTION]

- **Can assign a name to each column in view.**
- **If a list of column names is specified, it must have the same number of items as the number of columns produced by *subselect*.**
- **If omitted, each column takes the name of corresponding column in *subselect*.**
- **The table name must be specified if there is any ambiguity in a column name.**

SQL - CREATE VIEW

- **The *subselect* is known as the <u>defining query</u>（定义查询）.**
- **WITH CHECK OPTION ensures that if a row fails to satisfy WHERE clause of defining query, it is not added to underlying base table.**
- **Creating a view needs SELECT privilege on all tables referenced in subselect. Otherwise, there will be a data security problem.**

Example 3.55- Create Horizontal View

Create a view so that the manager at branch B003 can only see details for staff who work in his or her office.

```
CREATE VIEW Manager3Staff
AS      SELECT *
        FROM Staff
        WHERE branchNo = 'B003';
```

Table 6.3 Data for view Manager3Staff.

staffNo	fName	lName	position	sex	DOB	salary	branchNo
SG37	Ann	Beech	Assistant	F	10-Nov-60	12000.00	B003
SG14	David	Ford	Supervisor	M	24-Mar-58	18000.00	B003
SG5	Susan	Brand	Manager	F	3-Jun-40	24000.00	B003

Example 3.56- Create Vertical View

Create a view of staff details at branch B003 excluding salaries.

```
CREATE VIEW Staff3
 AS SELECT staffNo, fName, lName, position, sex
    FROM Staff
    WHERE branchNo = 'B003';
```

Table 6.4 Data for view Staff3.

staffNo	fName	lName	position	sex
SG37	Ann	Beech	Assistant	F
SG14	David	Ford	Supervisor	M
SG5	Susan	Brand	Manager	F

Example 3.57- Grouped and Joined Views

Create a view of staff who manage properties for rent, including the branch number they work at, staff number, and the number of properties they manage.

```
CREATE VIEW StaffPropCnt
                    (branchNo, staffNo, cnt)
 AS SELECT s.branchNo, s.staffNo, COUNT(*) as cnt
    FROM Staff s, Property  p
    WHERE s.staffNo = p.staffNo
    GROUP BY s.branchNo, s.staffNo;
```

Example 3.57- Grouped and Joined Views

Result table for Example 3.56

branchNo	staffNo	cnt
B003	SG14	1
B003	SG37	2
B005	SL41	1
B007	SA9	1

SQL - DROP VIEW

DROP VIEW ViewName [RESTRICT | CASCADE]

- **Causes the definition of view to be deleted from the DD of the database.**
- **For example:**

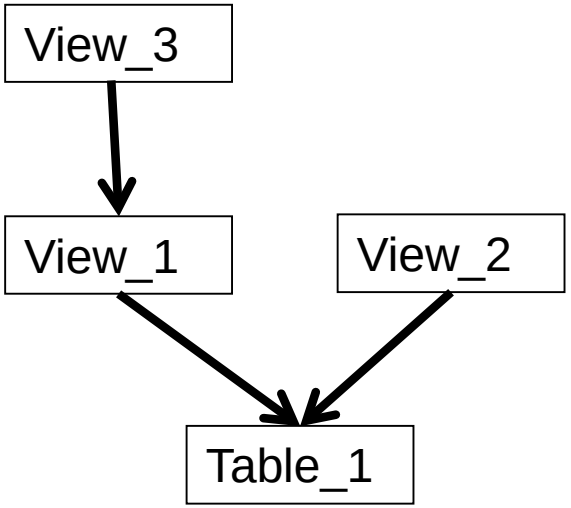
DROP VIEW Manager3Staff;

SQL - DROP VIEW

- **With CASCADE, all related dependent objects are deleted; i.e. any views defined on view being dropped.**
- **With RESTRICT (default), if any other objects depend for their existence on continued existence of view being dropped, command is rejected.**

SQL - DROP VIEW

- **RESTRICT (default)**



Drop view View_3 **succeed**

Drop view View_2 **succeed**

Drop view View_1 **fail**

Drop view View_1 **cascade** **succeed**

3.5.2 View Resolution (视图分解)

- **From the point of users' view, searching in views and searching in tables are the same.**
- **In fact, they are not the same because of view resolution.**
- **With <u>view resolution</u>, any operations on view are automatically translated into operations on relations from which it is derived.**

3.5.2 View Resolution

Count the number of properties managed by each member at branch B003.

View Definition:

```
CREATE VIEW StaffPropCnt
        (branchNo, staffNo, cnt)
AS SELECT s.branchNo, s.staffNo, COUNT(*)
     FROM Staff s, Property  p
     WHERE s.staffNo = p.staffNo
     GROUP BY s.branchNo, s.staffNo;
```

View Query:

```
SELECT staffNo, cnt
FROM StaffPropCnt
WHERE branchNo = 'B003'
ORDER BY staffNo;
```

（1）Process of View Resolution

(a) View column names in SELECT list are translated into their corresponding column names in the defining query:

SELECT s.staffNo As staffNo, COUNT(*) As cnt

(b) View names in FROM are replaced with corresponding FROM lists of defining query:

FROM Staff s, Property p

（1）Process of View Resolution

(c) WHERE from user query is combined with WHERE of defining query using AND:

```
WHERE s.staffNo = p.staffNo
      AND branchNo = 'B003'
```

(d) GROUP BY and HAVING clauses copied from defining query:

```
GROUP BY s.branchNo, s.staffNo
```

(e) ORDER BY copied from query with view column name translated into defining query column name

```
ORDER BY s.staffNo
```

（1）Process of View Resolution

(f) Final merged query is now executed to produce the result:

```
SELECT s.staffNo, COUNT(*)
FROM staff s, Property  p
WHERE s.staffNo = p.staffNo AND
                branchNo = ‘B003’
GROUP BY s.branchNo, s.staffNo
ORDER BY s.staffNo;
```

（2）Restrictions on Views

SQL imposes several restrictions on creation and use of views.

(a) If a column in a view is based on an aggregate function, then

- **The column may appear only in SELECT and ORDER BY clauses of queries that access the view.**
- **The column may not be used in WHERE nor be an argument to an aggregate function in any query based on view.**

（2）Restrictions on Views

- **For example, following query would fail:**

```
SELECT COUNT(cnt)
FROM StaffPropCnt;
```

- **Similarly, following query would also fail:**

```
SELECT *
FROM StaffPropCnt
WHERE cnt > 2;
```

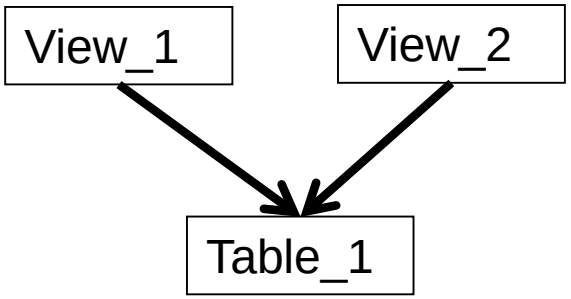
（2）Restrictions on Views

(b) A grouped view may never be joined with a base table or a view.

- **For example, StaffPropCnt view is a grouped view, so any attempt to join this view with another table or view fails.**

（3）View Updatability（视图的可更新性）

- **All updates to a base table should be reflected in all views that are based on the base table.**
- **Similarly, we may expect that if the view is updated then the base table(s) will reflect the change.**



（3）View Updatability

- **However, consider again view StaffPropCnt.**
- **If we tried to insert record showing that at branch B003, SG5 manages 2 properties:**

```
INSERT INTO StaffPropCnt
VALUES ('B003', 'SG5', 2);
```

- **We have to insert 2 records into Property showing which properties SG5 manages. However, we do not know which properties they are; i.e. do not know primary keys!**

（3）View Updatability

- **If we change the definition of the view and replace *count* with actual *property numbers*:**

```
CREATE VIEW StaffPropList (branchNo,
                    staffNo, propertyNo)
AS SELECT s.branchNo, s.staffNo,
                    p.propertyNo
    FROM Staff s, Property  p
    WHERE s.staffNo = p.staffNo;
```

（3）View Updatability

Property (propertyNo, Street, city, postcode, ownerNo, Type, rent, room, staffNo)

- **Now try to insert the record:**

```
INSERT INTO StaffPropList
VALUES ('B003', 'SG5', 'PG19');
```

- **Still problem, because in Property all columns except postcode/staffNo are not allowed nulls.**
- **However, we have no way of giving the remaining non-null columns values.**

（3）View Updatability

- ISO specifies the views that must be updatable in system that conforms to standard.
- A view is updatable if and only if:

  (1) DISTINCT is not specified.

  (2) Every element in SELECT list of defining query is a column name (not a constant, an expression or an aggregate function) and no column appears more than once.

（3）View Updatability

(3) FROM clause specifies only one table, excluding any views based on a join, union, intersection or difference.

(4) No nested SELECT referencing outer table (i.e. correlation subquery is not allowed to be used).

(5) No GROUP BY or HAVING clause.

Also, every row added through view must not violate integrity constraints of base table.

nested SELECT referencing outer table

```
INSERT INTO STUDENT(Sno, SNAME, SEX)
   SELECT Sno, SNAME, SEX
   FROM S
   WHERE 80<=all  ( SELECT g FROM SC
                          WHERE  S.Sno=SC.Sno);
```

Correlation subquery

```
SELECT staffNo, fName, lName, position
FROM Staff
WHERE branchNo =
        (SELECT branchNo
         FROM Branch
         WHERE street = '163 Main St');
```

Non-correlation subquery

Updatable View
（可更新视图）

For the view to be updatable, DBMS must be able to trace any row or column back to its row or column in the source table.

为了使视图可更新，ＤＢＭＳ必须具有以下能力：对于任何一个行或列都能追溯到其源表中相应的行或列。

（4）WITH CHECK OPTION

- The rows exist in a view because they satisfy WHERE condition of defining query.
- If a row changes and no longer satisfies condition, it disappears from the view.
- New rows will appear within the view when insert/update on the base table cause them to satisfy WHERE condition.
- The rows that enter or leave a view are called *migrating rows*.
- WITH CHECK OPTION prohibits a row migrating out of the view.

Example 3.58 - WITH CHECK OPTION

```
CREATE VIEW Manager3Staff
AS      SELECT *
        FROM Staff
        WHERE branchNo = 'B003'
        WITH CHECK OPTION;
```

- **In the above view, we cannot change the branch number of row B003 to B002 as this would cause row to migrate from view.**
- **Also we cannot insert a row into view with a branch number that does not equal B003.**
- **But in table staff, we could update branch number of row B003 to B002.**

WITH CHECK OPTION

WITH CHECK OPTION has no affect on Source Table.

```
CREATE VIEW view_80
 AS SELECT *
      FROM sc
      WHERE  grade > 80
      WITH CHECK OPTION ;

SELECT * FROM VIEW_80
```

Results | Messages

	sno	cno	grade
1	08000025	801	87
2	08300012	801	91
3	08300012	803	94
4	08300012	804	81
5	08300012	805	89
6	08300015	801	99

```
UPDATE view_80
SET grade=78
WHERE sno='08000025' AND cno='801'
```

WITH CHECK OPTION

```
UPDATE view_80
SET grade=78
WHERE sno='08000025' AND cno='801'
```

Messages

```
Msg 550, Level 16, State 1, Line 1
The attempted insert or update failed because the target view either specifies
WITH CHECK OPTION or spans a view that specifies WITH CHECK OPTION
The statement has been terminated.
```

```
UPDATE sc

SET grade=78

WHERE sno='08000025'

      AND cno='801‘
```

```
SELECT * FROM VIEW_80
```

Results | Messages

	sno	cno	grade
1	08300012	801	91
2	08300012	803	94
3	08300012	804	81
4	08300012	805	89
5	08300015	801	99
6	08300015	805	92

Advantages of Views

- **Data independence**

  tables change, view no change

- **Currency （实时性）**

  Changes of table are reflected in the view

- **Improved security**

  Each user can be given the privilege to access the DB only through a small set of views that contain the data appropriate for that user, thus restricting and controlling each user's access to the DB.

Advantages of Views

- **Reduced complexity**

  select * from view-name

- **Convenience**

  Just show the data that users need, not all data in DB

- **Customization** （个性化）

  different users see the same DB in different ways.

- **Data integrity**

  with check option

Disadvantages of Views

- **Update restriction**

  In some cases, a view can not be updated.

- **Structure restriction**

  The structure of a view is determined at the time of its creation. If the defining query was of the form SELECT * FROM…, then the * refers to the columns of the table present when the view is created. If columns are subsequently added to the table, then these columns will not appear in the view, unless the view is dropped and recreated.

- **Performance**

  Take a long time to process the view resolution which requires additional computer resources.

3.5.3 View Materialization

- View resolution mechanism may be slow, particularly if view is accessed frequently.
- View materialization stores view as temporary table when view is first queried.
- Thereafter, queries based on materialized view can be faster than recomputing view each time.
- Difficulty is maintaining the currency of view while base tables(s) are being updated.

Materialized Views

- Problem: each time a base table changes, the materialized view may change.
  - Cannot afford to recompute the view with each change.
- Solution: Periodic reconstruction of the materialized view, which is otherwise “out of date.”

3.6 Programmatic SQL

SQL in Real Programs

- We have seen only how SQL is used at the generic query interface --- an environment where we sit at a terminal and ask queries of a database, ***interactive SQL***.
- Reality is almost always different, SQL do not have Control flow command, such as IF… THEN…ELSE, GO TO or DO WHILE statements. So SQL are embedded in a conventional *host language,* ***Programmatic SQL.***

Methods of Programmatic SQL

- **PSM** (*persistent stored modules*). A collection of stored functions or procedures, some of which are host-language code and some of which are SQL statements. PSM is stored in the database itself, as part of the schema. (e.g., T-SQL, PL/SQL---**Stored procedure and trigger**)
- **Embedded SQL**. SQL statements are embedded in a *host language* (e.g., C). SQL statements need to be precompiled. **(需预编译SQL，** Static & Dynamic Embedded SQL**)**
- **API (*Application programming interface*)**. It is the connection tools that are used to allow a conventional language to access a database. It is a standard set of functions that can provide the same functionality as embedded statements and remove the need for any precompilation. **(无需预编译SQL, e.g.CLI, ODBC/JDBC, ADO**).

3.6 Programmatic SQL

3.6.1 PSM (*persistent stored modules*).

- Stored Procedure
- Constraints and Trigger

3.6.2 Embedded SQL

- Static Embedded SQL
- Dynamic Embedded SQL

3.6.3 API (*Application programming interface*).

- CLI
- ODBC
- JDBC

3.6.1 PSM

- PSM or SQL/PSM (*persistent stored modules*) is part of the latest revision to the SQL standard, called **SQL:2003**. It allows us to write stored procedures and user-defined functions as database schema elements.
- PSM = a mixture of conventional statements (if, while, etc.) and SQL.
- Let us do things we cannot do in SQL alone.
- Each commercial DBMS offers its own extension of PSM.
- PSM: (1) Stored procedures (2)Triggers

1. Stored procedures

- **SP is the program that is compiled ahead and stored in DBMS. It can complete the specified operations on DB.**
- **SP is the mixed set of SQL statements and control flow statements. It is compiled at the first time of being executed.**
- **SP can be called actively by an application program. Its executing speed is high.**

1. Stored procedures

```
CREATE PROCEDURE <name>(
        <parameter list> )
   <optional local declarations>
   <body>;
```

Stored procedures can:

- use parameters
- call another Stored procedure
- return a state value specifying success or failure
- return a value as the result
- be executed remotely

Syntax in SQL Server

```
create procedure [owner.]procedure_name[inumber]
   [[([@parameter_name datatype [=default][output]
   [,[,@parameter_name datatype [=default]
   [output] ]… [)]] [ with recompile]
    as sql_statements
```

Syntax for executing statement of SP

[execute][@return_status=]
[[[server.]database .] owner.]procedure_name
[inumber]
[[@parameter_name=]{value|@varible[output]}
[,[@parameter_name]{value|@varible[output]}]
…] [with recompile]

If the user get authority, he or she can remotely run the stored procedures on SQL SERVER DB. The name of DB Server need to be specified.

OUTPUT： declare this is a parameter that can return a value

WITH RECOMPILE： specify it needs recompiling when being executed every time

Stored procedure can include any number of SQL statements and can be nested 16 layers at most.

Example:

```
create procedure scorelist  @stu_name varchar (20)
as select sname, cno,grade
    from s ,sc
    where s.sno=sc.sno
            and sname=@stu_name
```

It is executed by： exec scorelist ‘Chen Li’

Advantages of Stored procedures (SP)

1.**Run fast**

2. **Modularized program design**

once built, run forever

3.Reduce the volume of network communication

There are huge of Transact-SQL statement in SP. When calling it, just need to send one statement (exec) in client-end and process the SQL code on the database server so that reduce the volume of network communication.

4.Guarantee the system security

Users are allowed to access critical data through SP instead of to access directly using Transact-SQL statement or Enterprise Manager.

e.g： create proc checkcourse @param varchar(8)

```
as if (select count(cno) from sc
        where sno=@param)>=1
          return 1
      else return 2
```

```
Create proc get_stat (@param varchar(8))
As   Declare @retvalue int
     Exec @retvalue=checkcourse @param
     If (@retvalue=1)
        Print 'The student has chosen courses'
     Else
        print  'The student does not choose any course'
```

exec get_stat ‘08300010’

(SQL Server中不加单引号，也可以)

With OUTPUT parameter

例：

```
create proc divide
    @dividend smallint ,
    @divisor  smallint ,
    @quotient int output
as if @divisor =0
  begin
    select @quotient=null
    return -100
  end
  select @quotient=@dividend/@divisor
  return 0
```

run the following statements：

```
declare @quot_param int
declare @retstat int
exec @retstat=divide @dividend=72, @divisor=8,
        @quotient=@quot_param output
select @retstat as retstat, @quot_param as quotient
```

retstat	quotient
0	9

结果 消息

	retstat	quotient
1	0	9

```
declare @quot_param int
declare @retstat int
exec @retstat=divide 72, 8, @quot_param output
```

（若不写output，则输出（0，null））

```
select @retstat as retstat, @quot_param as quotient
```

Create a SP to browse mark list

```
CREATE PROCEDURE mark
        @givensname char(20)
AS select sname,cname,g
   from s,sc,c
   where s.sno=sc.sno
         and sc.cno=c.cno
         and sname=@givensname
```

Execute a SP

EXEC mark ‘Chen Li’

sname	cname	grade
Chen Li	Data Structure	90
Chen Li	Database	85
Chen Li	Operating system	82

Example：Create a SP

Transfer an amount of money from Account 1 to Account 2

```
CREATE PROCEDURE transfer
  (@inAccount INT, @outAccount INT,
   @amount FLOAT)
/*define a SP named transfer，parameter：
intoAccount、outAccount、transferAmount*/
AS DECLARE   /*define variables*/
     @balance Float;   /*存放余额的变量*/
```

Example：Create a SP

```
BEGIN     /*SP main body*/
/*Check outAccount */
SELECT  Total  INTO  @balance
FROM   Accout
WHERE   accountnum=@outAccount ;

IF @balance  IS NULL THEN      /*If outAccount does not
BEGIN                            exist or have no fund */
    ROLLBACK; RETURN;          /*回滚事务*/
END;

IF @balance < @amount THEN   /*If balance is not enough*/
BEGIN
   ROLLBACK;                 /*回滚事务*/
   RETURN;
END ;
```

Example：Create a SP

```
/* Check inAccount */
IF @inAccount IS NULL  /* If inAccount does not exist */
THEN
BEGIN
   ROLLBACK;                    /*回滚事务*/
   RETURN;
END;
```

Example：Create a SP

```
/*transfer operation */
/* change the balance of outAccount, reduced by
transferAmount */
        UPDATE Account
        SET total=total-@amount
        WHERE accountnum=@outAccount;
/* change the balance of inAccount ， increased
by transferAmount */
        UPDATE Account
        SET total=total + @amount
        WHERE accountnum=@inAccount;
        COMMIT;                /*commit the transaction */
END;
```

Call a SP

Format：

CALL / PERFORM PROCEDURE SP-Name

([para**1,** para**2,...]);**

EXAMPLE：

Transfer $100 from Account **0103815868 to Account 0103813828**

In **Out**

CALL PROCEDURE transfer (0103813828, 0103815868, 100);

EXEC transfer 0103813828, 0103815868, 100; //SQL Server

SQL Server中只能用EXEC，不能用call调用存储过程。

Drop a SP

DROP PROCEDURE SP-Name;

EXAMPLE: **DROP PROCEDURE transfer;**

Example: Use SQL Server to modify the name of a student in table s from the oldName to a newName.

```
CREATE PROCEDURE changeName (@oldName CHAR(10),
                             @newName CHAR(10))
AS
BEGIN tran   /* tran是保留字，表示事务*/
    IF NOT EXISTS(  SELECT *
                    FROM s
                   WHERE sname=@oldName)
    BEGIN
        ROLLBACK;
        RETURN;
    END;
   UPDATE s
   SET sname=@newname
   WHERE sname=@oldName;
COMMIT tran; /*或者BEGIN后面不写 tran，将 commit tran 换成 END，也可以。
*/
```

2. Constraints and Triggers

(1) Constraints（约束）

A *constraint* is a relationship among data elements that the DBMS is required to enforce.

Two Kinds of Constraints

- **Attribute-based** constraints. (列级约束)
  - It constrains the values of a particular attribute.
- **Tuple-based** constraints. (表级约束)
  - It constrains the relationship among components（columns）.

Attribute-Based Checks

- Constraints on the value of a particular attribute.
- Add **CHECK(<condition>)** to the declaration for the attribute.
- **Timing of Checks**: Attribute-based checks are performed only when a value for that attribute is **inserted or updated**.

Example: **S(SNO,SN,age,sex)**

```
CREATE TABLE S
  ( SNO CHAR(4) NOT NULL,
    SN CHAR(8) NOT NULL,
     AGE SMALLINT check (age>17) ,
     SEX CHAR(1),
    PRIMARY KEY (SNO)
  );
```

Tuple-Based Checks

- **CHECK (<condition>)** may be added as a relation-schema element.
- The condition may refer to any attribute of **the relation**.
- Checked on **insert or update** only.

Example: **S(SNO,SN,age,sex)**

```
CREATE TABLE S
  ( SNO CHAR(4) NOT NULL,
    SN CHAR(8) NOT NULL,
    AGE SMALLINT,
    SEX CHAR(1),
    PRIMARY KEY (SNO) ,
    check((sex='f' and age<21) or
          (sex='m' and age<23))
  );
```

Motivation for Trigger

- Attribute- and tuple-based checks are checked at known times, but are **not powerful**.

- **Triggers** let the user decide when to check for any condition, **not only on insert or update，’delete’ also can invoke triggers.**

(2) Triggers

- *Triggers* are code stored in the database and **invoked** (*triggered*) ***by events*** that occur in the database.

- Triggers are **only executed** when a specified condition occurs, e.g., insertion of a tuple.

- It is **Easier to implement** than complex constraints.

Event-Condition-Action Rules

- Another name for “trigger” is *ECA rule*, or *event-condition-action* rule.
- ***Event*** : typically a type of database modification, e.g., “insert on Student.”
- ***Condition*** : Any SQL boolean-valued expression, e.g., age<18.
- ***Action*** : Any SQL statements.

Trigger in SQL SERVER

- **Trigger is a special kind of stored procedure in which parameters are not allowed.**
- **Triggers can not be called directly by Users, only can be automatically triggered and executed by system when given data items are modified.**
- **Triggers are used to guarantee the data integrity, i.e., the match between PK and FK, also used to implement the complex business rules.**

Trigger in SQL SERVER

- **Triggers can not be created on temporary tables, but temporary tables can be used in triggers.**
- **There are two special temporary tables in SQL SERVER, i.e., inserted and deleted, which have the same structures with the trigger table or view.**
- **Users can refer the above two temporary tables , but can not modify the data in them.**

- **When doing *inserting* operation, the inserted row(s) is (are) also copied to the temporary table *inserted* .**
- **When doing *deleting* operation, the deleted row(s) is (are) also copied to the temporary table *deleted* .**
- **When doing *updating* operation, first delete the old row(s) which is (are) also copied to the temporary table *deleted* , then insert the new row(s) which is (are) also copied to the temporary table *inserted* .**

Syntax for CREATE Triggers statement

CREATE TRIGGER [owner.] trigger-name

ON [owner.] table-name

{FOR { INSERT, UPDATE, DELETE}

//case 1，perform the actions provided that the event occurs. (row-level trigger,行级触发器)

AS <SQL statement>

FOR {INSERT，UPDATE}

AS IF UPDATE（<column-name>）

[{AND|OR} UPDATE (< column-name >)……]

<SQL statement>}

//case 2，perform the actions only when the specified column is modified.

(column-level trigger, 列级触发器)

Insert into s values(‘s6’,’ss6’,19)

inserted **(sno,sname,age,sex).**

Delete from sc where sno=‘s1’

Deleted **(sno,cno,grade) .**

inserted

sno	sname	age	sex
s6	ss6	19	

deleted

sno	cno	grade
s1	c2	89
s1	c4	96
s1	c5	84

Two Types of Triggers in SQL SERVER

1. **AFTER (or For can only be created on tables.)**

   (1) Triggers are only awakened when certain events, such as *Insert, Update or Delete*, occur.

   (2) The trigger tests a condition, i.e., Checking on the constraint.

   - **If the condition does not hold, then nothing else associated with the trigger happens in response to this event.**
   - **If the condition is satisfied, the actions of AFTER triggers is performed by DBMS.**

Two Types of Triggers in SQL SERVER

2. **INSTEAD OF (can be created both on tables and views)**

- **If a view is created with "with check option", a trigger can not be created on it.**
- **When a trigger is defined on a view, we can use Instead of in place of AFTER.**
- **If we do so, then when an event awakens the trigger, the action of the trigger is done instead of the event itself.**

SQL SERVER中两种类型的触发器

1. **AFTER 类型(或 For 只能建于基本表上)**

   - 当某一事件，如***Insert, Update*** 或 ***Delete***发生时，触发器才会被触发。
   - 触发器测试条件，即检查约束性。若条件不成立，则针对此事件，不会引发相关的触发器。
   - 若条件满足, 则**DBMS**执行**AFTER** 触发器的动作.

2. **INSTEAD OF类型 (既可建于基本表上，也可建于视图上)**

   - 若视图在创建时使用了**“with check option”**选项, 则不能在其上创建触发器。
   - 当在一个视图上定义了一个触发器，可以用**Instead of**代替**AFTER**触发器。
   - 若如此，当一个事件唤醒触发器时，则执行该触发器的动作，而不执行该事件本身。

Notes

- **Each event of *insert, update or delete* on one table or view can have only one INSTEAD OF trigger.**

- **Each event of *insert, update or delete* on one table can have many AFTER triggers.**

- **Executing process of AFTER trigger**
  If an operation of insert, update or delete violate the data integrity, then the actions of AFTER triggers won't be executed because the checking on constraint is done before the actions of the trigger.

特别说明

- 针对一个基本表或视图上的 ***insert, update 或 delete*** 的每个事件，只能定义一个**INSTEAD OF** 类型的触发器.
- 针对一个基本表上的 ***insert, update*** 或 ***delete*** 的每个事件，可以定义多个**AFTER** 类型的触发器.
- **AFTER 触发器的执行过程**
  - 在执行触发器动作之前, 先检查完整性约束；
  - 因此，若 **insert, update** 或 **delete** 操作违反了数据完整性，则 **AFTER** 触发器的动作不会被执行。

Preliminary Example: A Trigger

Instead of using a foreign-key constraint and rejecting insertions into sc(sno, cno, grade) with unknown sno, a trigger can add that sno to Table s, with other columns as NULL values in Table s.

s

sno	sname	age	sex
s1	ss1	18	f
s2	ss2	19	m

sc

sno	cno	grade
s1	c1	90
s3	c2	87

Being rejected !

Trigger Definition in SQL Server

```
CREATE TRIGGER sc_Trig ON sc
AFTER  INSERT
AS  if ((select sno from inserted)
        NOT IN (SELECT sno FROM s))
INSERT INTO s(sno)
select sno from inserted;
```

Trigger table

Has the same structure with sc

Has the same structure with sc

若条件为真，执行此语句

s

sno	sname	age	sex
s1	ss1	18	f
s2	ss2	19	m
s3	null	null	null

SC

sno	cno	grade
s1	c1	90
s3	c2	87

Trigger that guarantees deleting in cascading way

```
CREATE TRIGGER  dele_trig  ON s
FOR  DELETE
AS DELETE sc FROM deleted, sc
    where sc.sno=deleted.sno
```

- There must be sc after DELETE.
- sc after FROM is not essential.
- DELETE后必须有sc, FROM后有无sc均可

```
DELETE sc FROM s, sc
where sc.sno=s.sno  and sname='张三'
```

Correct!

Column-level Trigger in SQL Server

Example : Create a trigger to stop the attempt to lower the grade of a student.

```
CREATE TRIGGER No_lower_Grade ON  sc
FOR UPDATE
AS IF UPDATE(grade)
      IF ((SELECT grade FROM deleted) >
            (SELECT grade FROM inserted))

            ROLLBACK TRANSACTION ;
```

or

```
CREATE TRIGGER No_lower_Grade ON  sc
FOR UPDATE
AS IF UPDATE(grade)
      IF((SELECT grade FROM deleted) >
          (SELECT grade FROM inserted))
        UPDATE  sc
       SET grade= (SELECT grade FROM deleted
        WHERE sno= (SELECT sno FROM inserted)
             and cno= (SELECT cno FROM inserted);
```

Yes!

deleted ?

SC

sno	cno	grade
s1	c1	87

deleted

sno	cno	grade
s1	c1	90

inserted

sno	cno	grade
s1	c1	87

Triggers on Views

- Generally, it is impossible to modify a virtual view, because it doesn't exist.
- But an **INSTEAD OF** trigger let us interpret view modifications in a way that makes sense.

‘Instead of’ Trigger

```
CREATE VIEW B003_Staff
As select StaffNo, lname
    from Staff
    where branchno='B003';
```

Example: INSERT a new row into view B003_Staff

We cannot insert into a virtual view.

So we need to interpret a View Insertion（view resolution）

Example: Instead of Trigger

```
CREATE VIEW B003_Staff
As select StaffNo, lname
    from Staff
    where branchno='B003';
```

Trigger view

```
// In SQL SERVER
CREATE TRIGGER B003_insert ON B003_Staff
INSTEAD OF INSERT
As INSERT INTO Staff (staffNo, lname, branchNo)
    SELECT sno, sname, 'B003'
    FROM inserted;
```

Inserted (StaffNo, lname)