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FAKULTAS ILMU KOMPUTER

11

Trigger and Stored Procedure

CSF2600700 - BASIS DATA

Acknowledgements

This slide is a modification to supplementary slide of "Database System", 7th edition, Elmasri/Navathe, 2015: **Chapter 7 More SQL: Complex Queries, Triggers, Views, and Schema Modification** used in "Basis Data" course in academic years 2018/2019 in the Faculty of Computer Science, Universitas Indonesia.

Outline

1. Stored Procedure

2. Trigger

Stored Procedure

Sebuah stored procedure adalah kumpulan dari prosedur dan statement SQL yang terdapat pada DBMS.

- ➔ Dikenali dengan name
- ➔ Dieksekusi sebagai sebuah kesatuan (unit).
- ➔ Di postgresql juga dikenal sebagai **function**.

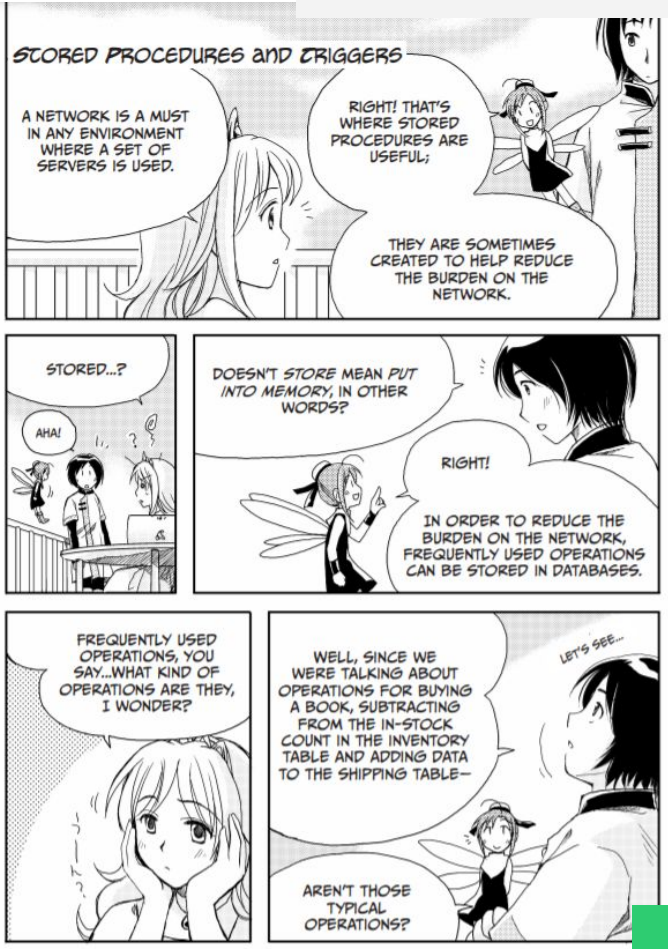


Illustration: Takahashi & Azuma (2014)

Keuntungan Stored Procedure

- ➔ **Reusable**.
- ➔ **Mengurangi network traffic** dan meningkatkan performance (mengurangi transmisi individual SQL statements pada network).

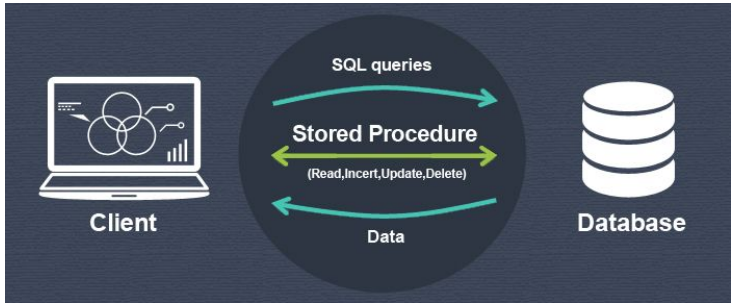


Illustration: Apptha.com

General Form

Procedure

```
CREATE [or REPLACE] <procedure name> (<parameters>)
<local declarations>
<procedure body>
LANGUAGE <language>;
```

Function

```
CREATE [or REPLACE] <function name> (<parameters>)
RETURNS <return type>
<local declarations>
<function body>
LANGUAGE <language>;
```

Example (1)

```
CREATE or REPLACE FUNCTION one()
RETURNS integer AS
$$
     SELECT 1 AS result;
$$
LANGUAGE SQL;
```

Tanda **$$** dapat diganti dengan single quote (‘)

Eksekusi dilakukan dengan memanggil:

```
SELECT one();
```

Example (1): Result

```
postgres=# CREATE or REPLACE FUNCTION one() RETURNS integer AS
postgres-# $$
postgres$#     SELECT 1 AS result;
postgres$# $$
postgres-# LANGUAGE SQL;
CREATE FUNCTION
postgres=# select one();
 one
-----
   1
(1 row)
```

Example (2)

```
CREATE or REPLACE FUNCTION add_em(x integer, y integer)
RETURNS integer AS
$$
     SELECT x + y;
$$
LANGUAGE SQL;
```

Eksekusi dilakukan dengan memanggil:

```
SELECT add_em(1,2);
```

Misalnya untuk x=1 dan y=2

Example (3)

```
CREATE or REPLACE FUNCTION hellow()
RETURNS text AS
$$
     DECLARE
     hello text;
     BEGIN
     hello := 'Hello World!';
     RETURN hello;
     END
$$
LANGUAGE plpgsql;
```

Eksekusi dilakukan dengan memanggil:

```
SELECT hellow();
```

Example (3): Result

```
postgres=# CREATE or REPLACE FUNCTION hellow() RETURNS text AS
postgres-# $$
postgres$# DECLARE
postgres$#   hello text;
postgres$# BEGIN
postgres$#   hello := 'Hello World!’;
postgres$#   return hello;
postgres$# END
postgres$# $$ LANGUAGE plpgsql;
CREATE FUNCTION
postgres=# select hellow();
    hellow
--------------
 Hello World!
```

Example (4)

```
CREATE or REPLACE FUNCTION sum_salary()
RETURNS integer AS
$$
     DECLARE result integer;
     BEGIN
     SELECT sum(salary) into result FROM employee;
     RETURN result;
     END;
$$
LANGUAGE plpgsql;
```

Eksekusi dilakukan dengan memanggil:

```
SELECT sum_salary();
```

Outline

1. Stored Procedure

2. Trigger

Trigger

Trigger merupakan kode PL/SQL yang secara otomatis dijalankan oleh DBMS jika suatu event database terjadi.

- ➔ Event tersebut bisa berupa operasi `INSERT, UPDATE, DELETE`
- ➔ Sebuah trigger selalu dijalankan sebelum atau sesudah sebuah data row di-`INSERT`, di-`UPDATE` atau di-`DELETE`.
- ➔ Sebuah trigger selalu berasosiasi dengan tabel pada basis data.
- ➔ Setiap tabel bisa mempunyai satu atau lebih trigger
- ➔ Sebuah trigger dieksekusi sebagai bagian dari transaksi yang men-trigger trigger tersebut

Keuntungan Trigger

- ➔ Trigger dapat digunakan untuk memaksakan **constraint** yang tidak dapat dilakukan pada perancangan dan implementasi DBMS.
- ➔ Trigger dapat secara otomatis memberikan pesan **warning** jika terjadi gangguan pada IC. Penggunaan trigger yg umum adalah untuk meningkatkan referential IC.
- ➔ Trigger dapat digunakan untuk update nilai pada tabel, insert tuple pada tabel, dan memanggil stored procedure yg lain

Trigger and Stored Procedure

```
CREATE TRIGGER name { BEFORE | AFTER } { event [ OR ... ] }
ON table_name [ FOR [ EACH ] { ROW | STATEMENT } ]
[WHEN (condition)]
EXECUTE {FUNCTION | PROCEDURE} function_name ( arguments );
```

Typical TRIGGER components: **E**, C, A

Event(s)

- ➔ These are usually DB updates.
- ➔ Specified after the keyword BEFORE (or AFTER)

Trigger and Stored Procedure

```
CREATE TRIGGER name { BEFORE | AFTER } { event [ OR ... ] }
ON table_name [ FOR [ EACH ] { ROW | STATEMENT } ]
[WHEN (condition)]
EXECUTE {FUNCTION | PROCEDURE} function_name ( arguments );
```

Typical TRIGGER components: E, **C**, A

Condition(s)

- ➔ The check whether the rule action should be executed. It is specified in the WHEN clause.
- ➔ If no condition, the execution will be executed whenever the event occurs. If there is a condition, the condition is first evaluated, and only if it is true will the rule action be executed.
- ➔ This can also be defined in the function or procedure

Trigger and Stored Procedure

```
CREATE TRIGGER name { BEFORE | AFTER } { event [ OR ... ] }
ON table_name [ FOR [ EACH ] { ROW | STATEMENT } ]
[WHEN (condition)]
EXECUTE {FUNCTION | PROCEDURE} function_name ( arguments );
```

Typical TRIGGER components: E, C, **A**

Action(s)

➔ The action can be SQL statements or a stored procedure or function.

Company DB

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 5.5
Schema diagram for the COMPANY relational database schema.

Example (5)

Suppose we want to check whenever an employee's salary is greater than the salary of his/her direct supervisor in the COMPANY DB

Can you guess **what events can trigger this situation?**

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 5.5
Schema diagram for the COMPANY relational database schema.

Example (5)

Suppose we want to check whenever an employee's salary is greater than the salary of his/her direct supervisor in the COMPANY DB

Can you guess **what events can trigger this situation?**

- ➔ Inserting a new employee record
- ➔ Updating an employee's salary
- ➔ Updating an employee's supervisor

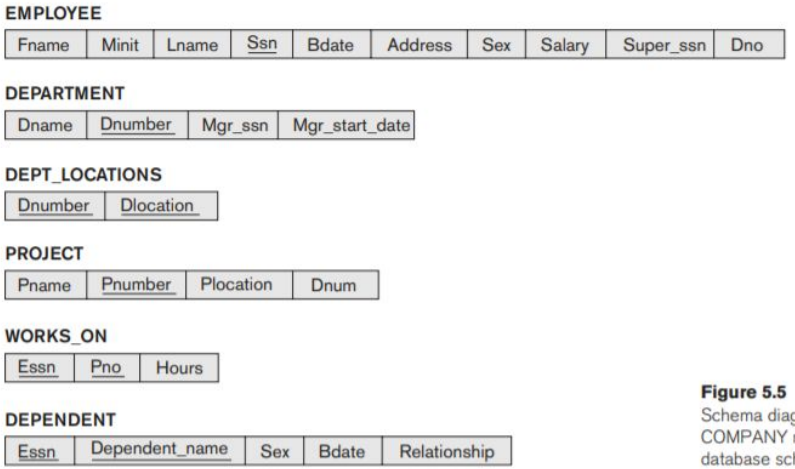


Figure 5.5
Schema diagram for the COMPANY relational database schema.

Example (5): Function/Stored Procedure

Suppose we want to check whenever an employee's salary is greater than the salary of his/her direct supervisor in the COMPANY DB

```
CREATE OR REPLACE FUNCTION INFORM_SUPERVISOR() RETURNS trigger AS
$$
      BEGIN
      IF(NEW.SALARY >(SELECT SALARY FROM EMPLOYEE WHERE SSN = NEW.SUPER_SSN))
      THEN
      RAISE EXCEPTION '% salary cannot greater than his/her supervisor salary',
      OLD.FNAME;
      END IF;
      RETURN NEW;
      END;
$$
LANGUAGE plpgsql;
```

Example (5): Trigger

Suppose we want to check whenever an employee's salary is greater than the salary of his/her direct supervisor in the COMPANY DB

```
CREATE TRIGGER SALARY_VIOLATION
BEFORE INSERT OR UPDATE OF SALARY
ON EMPLOYEE
FOR EACH ROW EXECUTE PROCEDURE INFORM_SUPERVISOR();
```

Example (5): Result 1

```
UPDATE employee SET salary = 45000 WHERE ssn = '123456789';
```

```
postgres=# update employee set salary = 45000 where ssn = '123456789';
ERROR:  John salary cannot greater than his/her supervisor salary
CONTEXT:  PL/pgSQL function inform_supervisor() line 5 at RAISE
```

```
postgres=# select * from employee;
  fname   | minit |  lname   |    ssn    |   bdate    |  address   | sex |  salary  | super_ssn | dno
----------+-------+----------+-----------+------------+------------+-----+----------+-----------+----
 Ramesh   |       | Narayan  | 666884444 |            |            | F   | 38000.00 | 888665555 |   5
 Alicia   | J     | Zelaya   | 999887777 | 1968-01-19 | Castle     | F   | 25000.00 |           |   4
 Ahmad    |       | Jabbar   | 987987987 |            |            | M   | 25000.00 | 987654321 |   4
 Joyce    |       | English  | 453453453 |            |            | F   | 25000.00 | 987654321 |   5
 Jennifer | S     | Wallace  | 987654321 | 1941-06-19 | Bellaire   | F   | 43000.00 | 333445555 |   4
 James    |       | Borg     | 888665555 |            |            | M   | 55000.00 | 333445555 |   1
 Franklin | T     | Wong     | 333445555 | 1955-12-08 | Houston    | M   | 40000.00 | 888665555 |   5
 John     | B     | Smith    | 123456789 | 1965-01-09 | Fondren    | M   | 30000.00 | 333445555 |   5
```

Example (5): Result 2

```
UPDATE employee SET salary = 25000 WHERE ssn = '123456789';
```

```
postgres=# UPDATE employee SET salary = 25000 where ssn = '123456789';
UPDATE 1
postgres=# select * from employee;
  fname   | minit |  lname   |    ssn    |   bdate    | address  | sex |  salary  | super_ssn | dno
----------+-------+----------+-----------+------------+----------+-----+----------+-----------+-----
 Joyce    |       | English  | 453453453 |            |          | F   | 25000.00 | 987654321 |   5
 Ramesh   |       | Narayan  | 666884444 |            |          | F   | 38000.00 | 888665555 |   5
 Ahmad    |       | Jabbar   | 987987987 |            |          | M   | 25000.00 | 987654321 |   4
 Alicia   | J     | Zelaya   | 999887777 | 1968-01-19 | Castle   | F   | 25000.00 |           |   4
 Jennifer | S     | Wallace  | 987654321 | 1941-06-19 | Bellaire | F   | 43000.00 | 333445555 |   4
 James    |       | Borg     | 888665555 |            |          | M   | 55000.00 | 333445555 |   1
 Franklin | T     | Wong     | 333445555 | 1955-12-08 | Houston  | M   | 30000.00 | 888665555 |   5
 John     | B     | Smith    | 123456789 | 1965-01-09 | Fondren  | M   | 25000.00 | 333445555 |   5
```

Example (6)

Mengecek bahwa SALARY dari EMPLOYEE tidak boleh bernilai negatif.

Yang menjadi trigger:

- ➔ Insert new employee
- ➔ Update employees' salary

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 5.5
Schema diagram for the COMPANY relational database schema.

Example (6): Function/Stored Procedure

Mengecek bahwa SALARY dari EMPLOYEE tidak boleh bernilai negatif.

```
CREATE OR REPLACE FUNCTION emp_stamp()
RETURNS trigger AS
$$
      BEGIN
      IF (NEW.salary < 0) THEN
      RAISE EXCEPTION '% cannot have negative salary',NEW.lname;
      END IF;
      RETURN NEW;
      END;
$$
LANGUAGE plpgsql;
```

Example (6): Trigger

Mengecek bahwa SALARY dari EMPLOYEE tidak boleh bernilai negatif.

```
CREATE TRIGGER emp_stamp
BEFORE INSERT OR UPDATE OF SALARY
ON employee
FOR EACH ROW EXECUTE  PROCEDURE emp_stamp();
```

Example (6): Result 1

```
INSERT INTO EMPLOYEE VALUES ('Donald','T','Duck','123456788','1950-11-11',
'Manhattan','M',-100, NULL,1);
```

```
postgres=# select * from employee;
 fname    | minit | lname    |    ssn     |   bdate    | address  | sex |  salary  | super_ssn | dno
----------+-------+----------+------------+------------+----------+-----+----------+-----------+-----
 John     | B     | Smith    | 123456789  | 1965-01-09 | Fondren  | M   | 30000.00 | 333445555 |   5
 Franklin | T     | Wong     | 333445555  | 1955-12-08 | Houston  | M   | 40000.00 | 888665555 |   5
 Joyce    |       | English  | 453453453  |            |          | F   | 25000.00 | 987654321 |   5
 Ramesh   |       | Narayan  | 666884444  |            |          | F   | 38000.00 | 888665555 |   5
 James    |       | Borg     | 888665555  |            |          | M   | 55000.00 | 333445555 |   1
 Jennifer | S     | Wallace  | 987654321  | 1941-06-19 | Bellaire | F   | 43000.00 | 333445555 |   4
 Ahmad    |       | Jabbar   | 987987987  |            |          | M   | 25000.00 | 987654321 |   4
 Alicia   | J     | Zelaya   | 999887777  | 1968-01-19 | Castle   | F   | 25000.00 |           |   4
(8 rows)


postgres=# INSERT INTO EMPLOYEE VALUES('Donald','T','Duck','123456788','1950-11-11','Manhattan','M','
-100',NULL,1);
ERROR:  Duck cannot have negative salary
CONTEXT:  PL/pgSQL function emp_stamp() line 2 at RAISE
```

Example (6): Result 2

```
INSERT INTO EMPLOYEE VALUES ('Donald','T','Duck','123456788','1950-11-11',
'Manhattan','M',20000.00, NULL,1);
```

```
postgres=# INSERT INTO EMPLOYEE VALUES('Donald','T','Duck','123456788','1950-11-11','Manhattan','M','
20000',NULL,1);
INSERT 0 1
postgres=# select * from employee;
  fname   | minit |  lname   |    ssn    |   bdate    |  address  | sex |  salary  | super_ssn | dno
----------+-------+----------+-----------+------------+-----------+-----+----------+-----------+-----
 John     | B     | Smith    | 123456789 | 1965-01-09 | Fondren   | M   | 30000.00 | 333445555 |   5
 Franklin | T     | Wong     | 333445555 | 1955-12-08 | Houston   | M   | 40000.00 | 888665555 |   5
 Joyce    |       | English  | 453453453 |            |           | F   | 25000.00 | 987654321 |   5
 Ramesh   |       | Narayan  | 666884444 |            |           | F   | 38000.00 | 888665555 |   5
 James    |       | Borg     | 888665555 |            |           | M   | 55000.00 | 333445555 |   1
 Jennifer | S     | Wallace  | 987654321 | 1941-06-19 | Bellaire  | F   | 43000.00 | 333445555 |   4
 Ahmad    |       | Jabbar   | 987987987 |            |           | M   | 25000.00 | 987654321 |   4
 Alicia   | J     | Zelaya   | 999887777 | 1968-01-19 | Castle    | F   | 25000.00 |           |   4
 Donald   | T     | Duck     | 123456788 | 1950-11-11 | Manhattan | M   | 20000.00 |           |   1
(9 rows)
```

Example (7)

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

Misalkan hal ini dipengaruhi oleh penambahan atau penghapusan proyek baru untuk EMPLOYEE.

Catatan:
Relasi EMPLOYEE terlebih dulu di-update dengan melakukan penambahan kolom total_hours_project (dan meng-update isinya jika sebelumnya sudah ada assignment employee terhadap project tertentu).

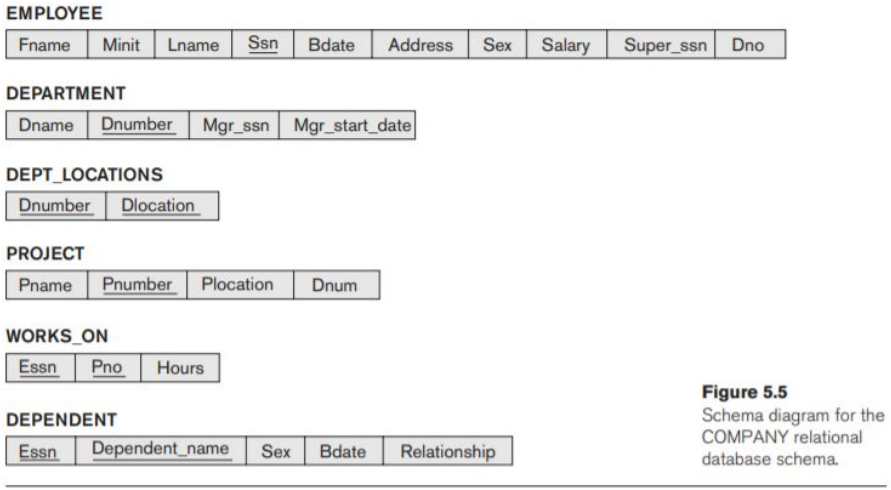


Figure 5.5
Schema diagram for the COMPANY relational database schema.

Example (7): Function/Stored Procedure

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

```
CREATE OR REPLACE FUNCTION emp_total_hours_proj()
RETURNS trigger AS
$$
      BEGIN
      IF (TG_OP = 'INSERT') THEN
      UPDATE employee SET total_hours_project = total_hours_project +NEW.hours
      WHERE ssn = NEW.essn;
      RETURN NEW;
      ELSIF (TG_OP = 'DELETE') THEN
      UPDATE employee SET total_hours_project = total_hours_project -OLD.hours
      WHERE ssn = OLD.essn;
      RETURN OLD;
      END IF;
      END;
$$
LANGUAGE plpgsql;
```

Example (7): Trigger

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

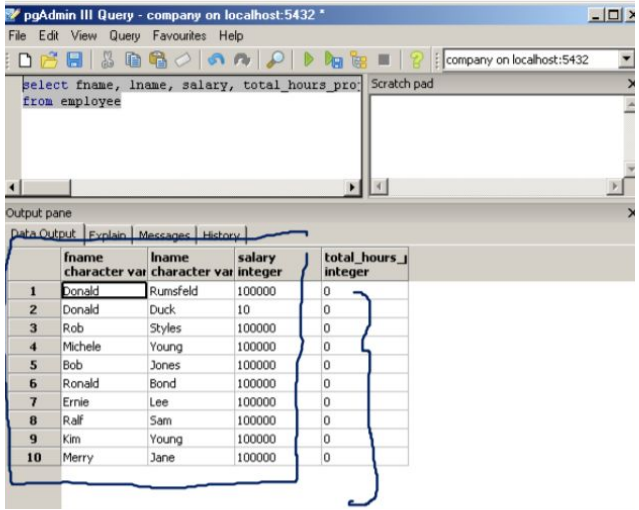
```
CREATE TRIGGER emp_total_hours_proj
AFTER INSERT OR DELETE ON works_on
FOR EACH ROW EXECUTE PROCEDURE emp_total_hours_proj();
```

Example (7): Implementation

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

```
SELECT FNAME, LNAME, SALARY, TOTAL_HOURS_PROJECT
FROM EMPLOYEE;
```

Sebelum meng-assign WORKS_ON



	fname character var	lname character var	salary integer	total_hours_ integer
1	Donald	Rumsfeld	100000	0
2	Donald	Duck	10	0
3	Rob	Styles	100000	0
4	Michele	Young	100000	0
5	Bob	Jones	100000	0
6	Ronald	Bond	100000	0
7	Ernie	Lee	100000	0
8	Ralf	Sam	100000	0
9	Kim	Young	100000	0
10	Merry	Jane	100000	0

Example (7): Implementation

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

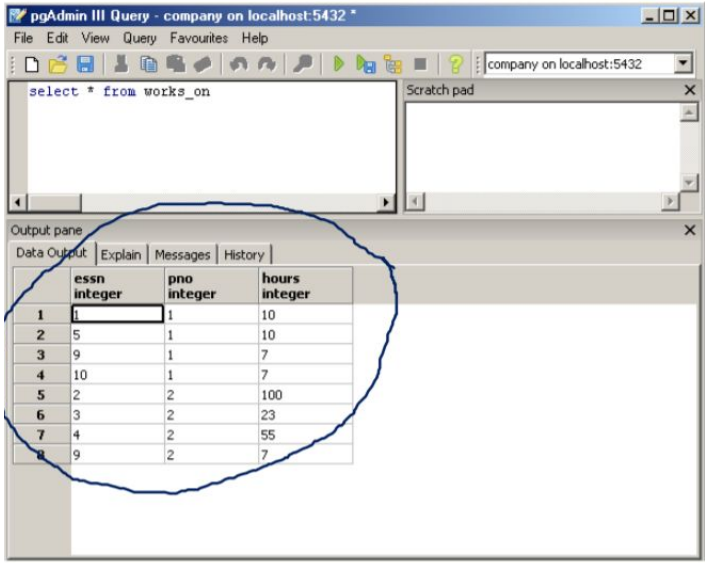
```
INSERT INTO PROJECT VALUES('1', 'New York','NYS Project', '1');
INSERT INTO WORKS_ON VALUES('1', '1', '10');
INSERT INTO WORKS_ON VALUES('5', '1', '10');
INSERT INTO WORKS_ON VALUES('9', '1', '7');
INSERT INTO WORKS_ON VALUES('10', '1', '7');

INSERT INTO PROJECT VALUES('2', 'New York', 'NYS2 Project', '1');
INSERT INTO WORKS_ON VALUES('2', '2', '100');
INSERT INTO WORKS_ON VALUES('3', '2', '23');
INSERT INTO WORKS_ON VALUES('4', '2', '55');
INSERT INTO WORKS_ON VALUES('9', '2', '7');
```

Example (7): Result

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

Tabel WORKS_ON



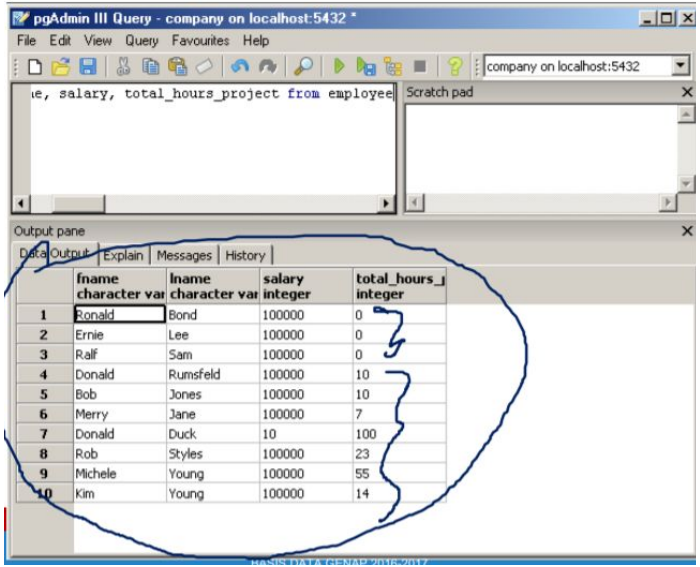
	essn integer	pno integer	hours integer
1	1	1	10
2	5	1	10
3	9	1	7
4	10	1	7
5	2	2	100
6	3	2	23
7	4	2	55
8	9	2	7

Example (7): Result

Mengakumulasi jumlah jam kerja EMPLOYEE pada PROJECT.

```
SELECT FNAME, LNAME, SALARY,TOTAL_HOURS_PROJECT
FROM EMPLOYEE;
```

Setelah meng-assign WORKS_ON



	fname character var	lname character var	salary integer	total_hours_ integer
1	Ronald	Bond	100000	0
2	Ernie	Lee	100000	0
3	Ralf	Sam	100000	0
4	Donald	Rumsfeld	100000	10
5	Bob	Jones	100000	10
6	Merry	Jane	100000	7
7	Donald	Duck	10	100
8	Rob	Styles	100000	23
9	Michele	Young	100000	55
10	Kim	Young	100000	14

Example (8)

Menghitung gaji total EMPLOYEE yang merupakan akumulasi SALARY dengan tunjangan yang bergantung pada jam kerja pada PROJECT.

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 5.5
Schema diagram for the COMPANY relational database schema.

Example (8): Function/Stored Procedure

Menghitung gaji total EMPLOYEE yang merupakan akumulasi SALARY dengan tunjangan yang bergantung pada jam kerja pada PROJECT.

```
CREATE OR REPLACE FUNCTION procedure_salary()
RETURNS void AS
$$
      BEGIN
      UPDATE employee SET salary = salary + total_hours_project * 10
      WHERE total_hours_project > 0;
      END;
$$
LANGUAGE plpgsql;
```

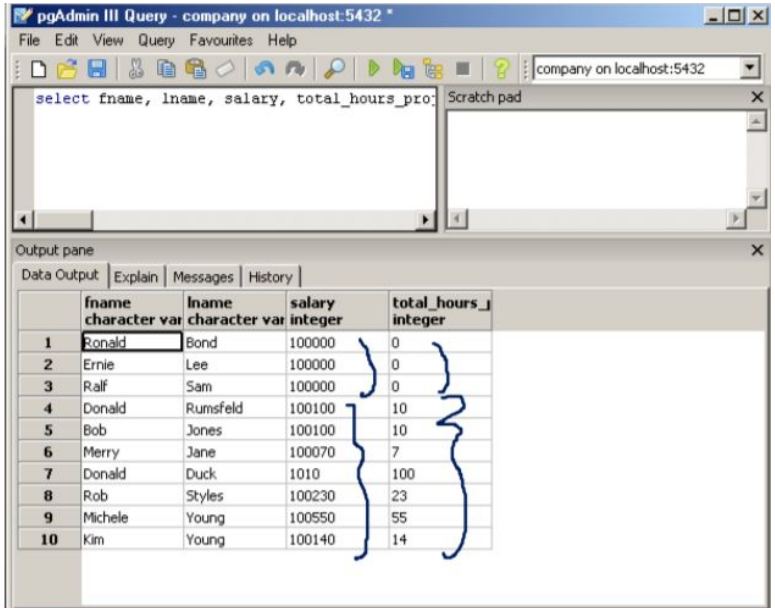
Example (8): Result

Menghitung gaji total EMPLOYEE yang merupakan akumulasi SALARY dengan tunjangan yang bergantung pada jam kerja pada PROJECT.

Untuk meng-execute dapat digunakan query sebagai berikut

```
SELECT * FROM PROCEDURE_SALARY();

SELECT fname, lname, salary,
total_hours_proj
FROM EMPLOYEE;
```



	fname character var	lname character var	salary integer	total_hours_ integer
1	Ronald	Bond	100000	0
2	Ernie	Lee	100000	0
3	Ralf	Sam	100000	0
4	Donald	Rumsfeld	100100	10
5	Bob	Jones	100100	10
6	Merry	Jane	100070	7
7	Donald	Duck	1010	100
8	Rob	Styles	100230	23
9	Michele	Young	100550	55
10	Kim	Young	100140	14

Trigger vs Stored Procedure

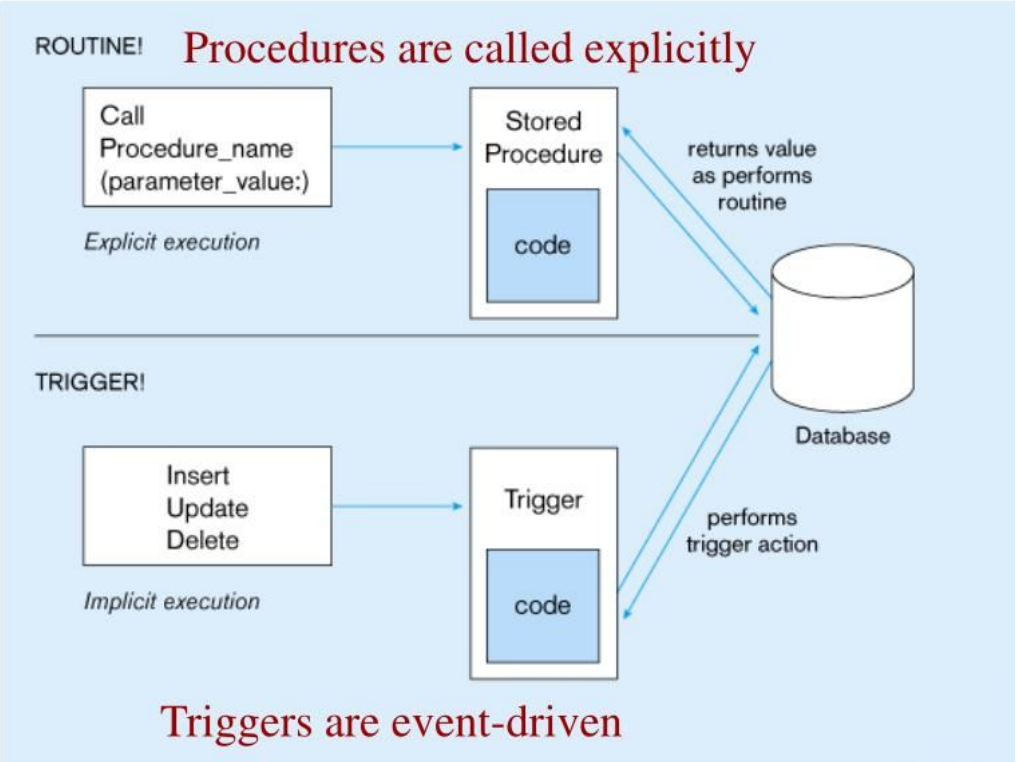


Illustration: Mullins (1995)

Q&A