CSIT115 Data Management and Security

# SELECT Statement (3)

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# SELECT statement (3)

## Outline

Join queries

Natural join queries

Column name join queries

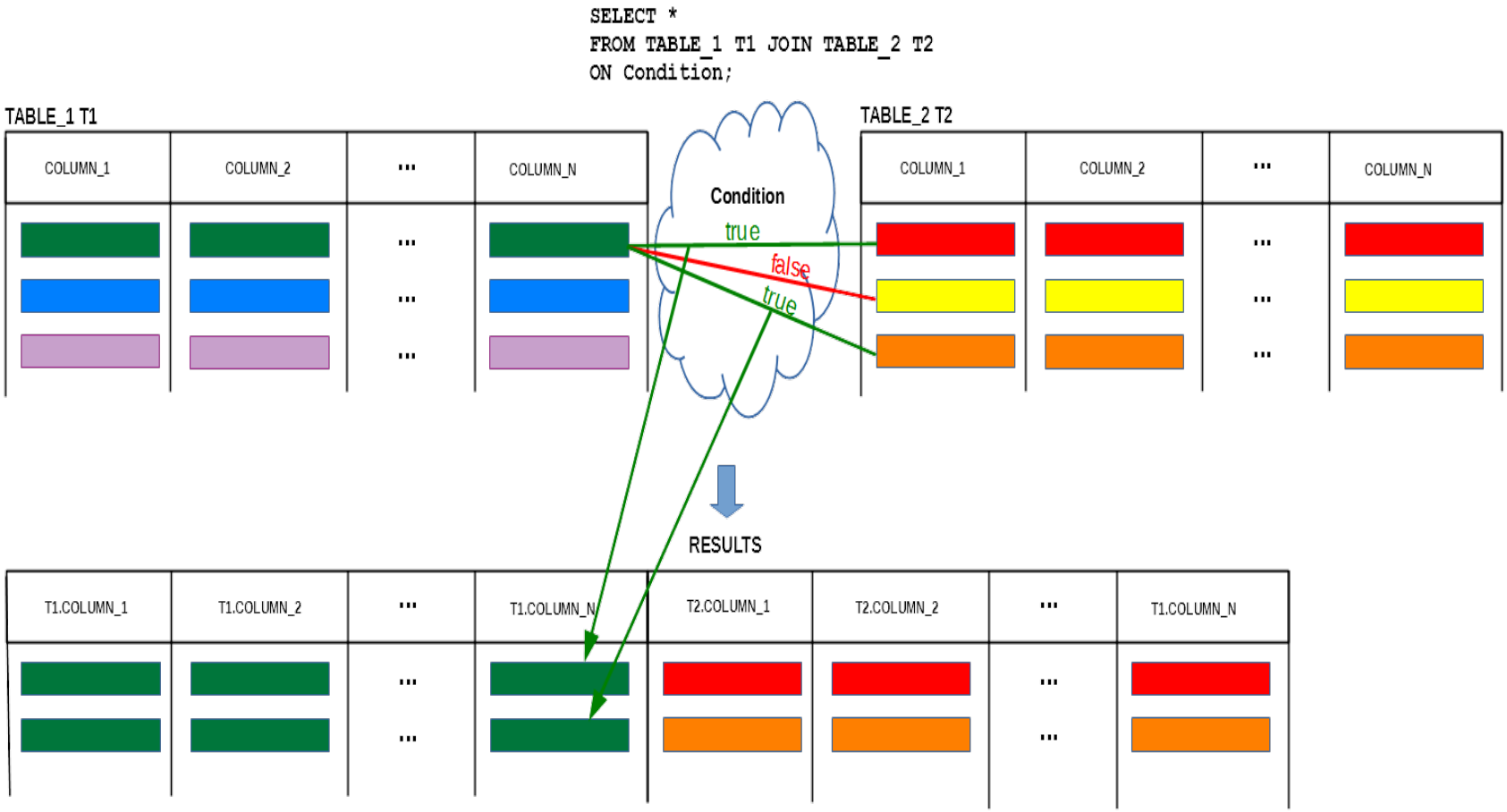
Cross join queries

Join queries over more than 2 tables

Self-join queries

# Join queries

Join operation "connects" the rows from two relational tables

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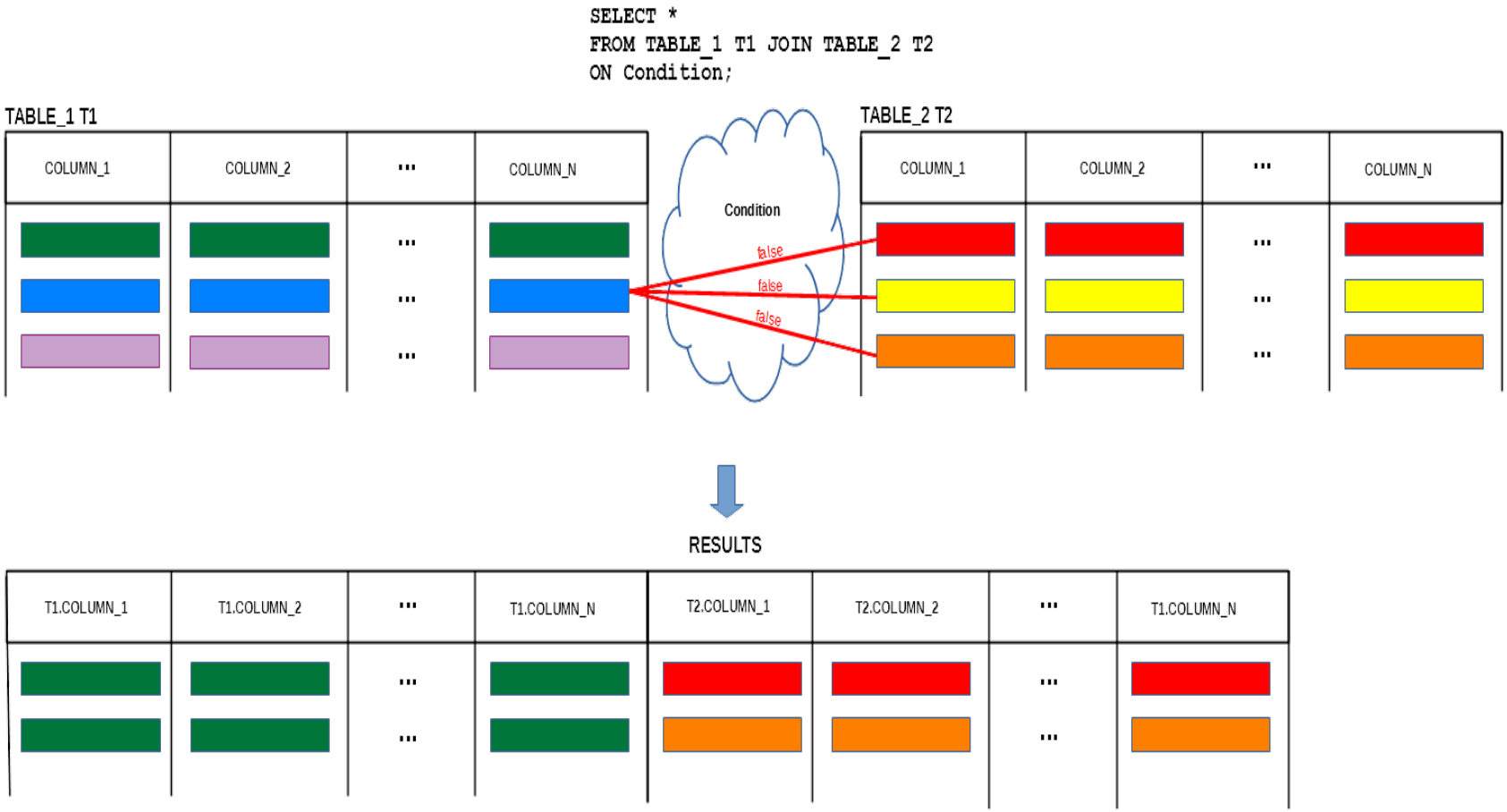
# Join queries

Join operation "connects" the rows from two relational tables

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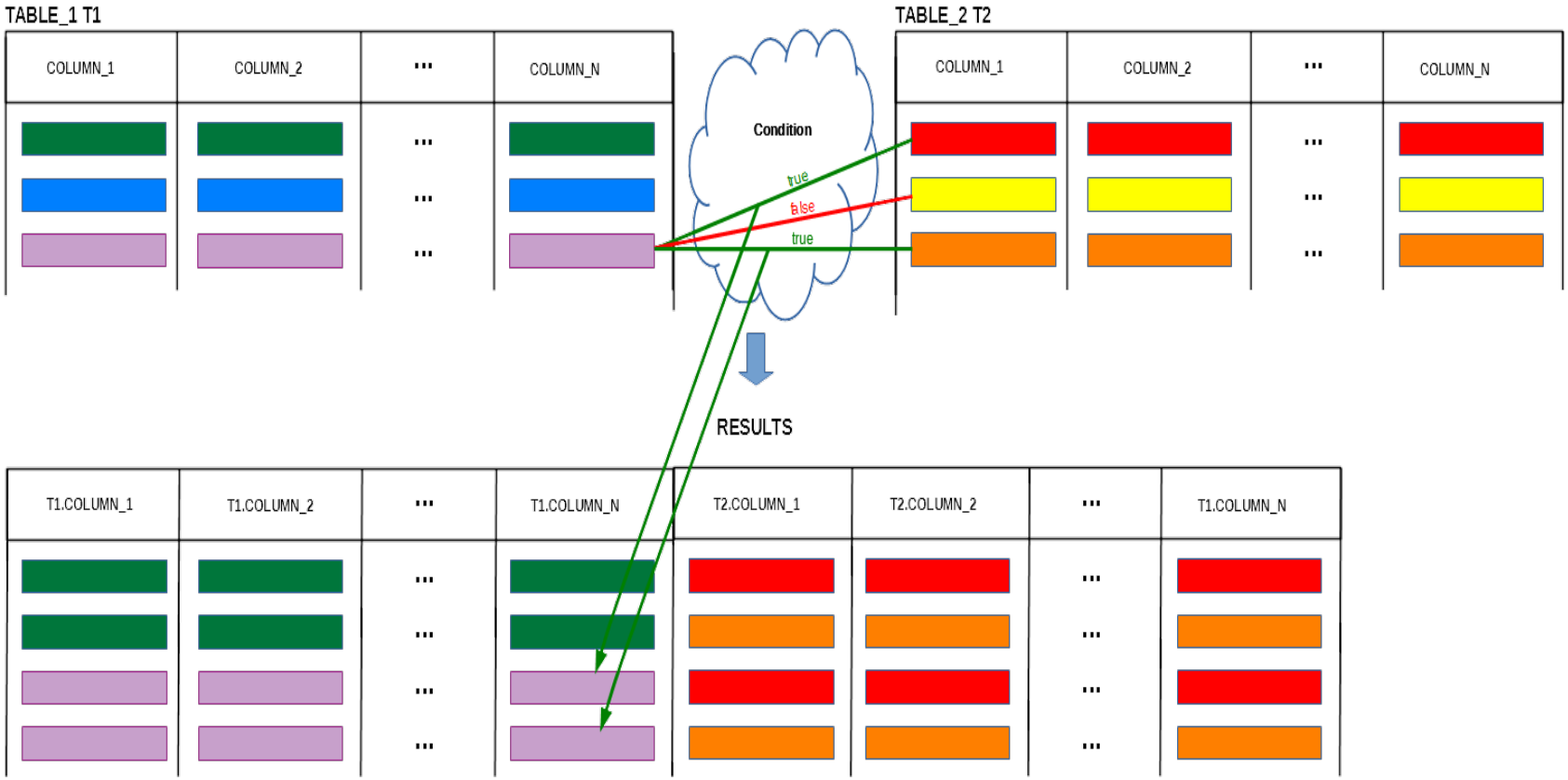
# Join queries

Join operation "connects" the rows from two relational tables

```
SELECT *
FROM TABLE_1 T1 JOIN TABLE_2 T2
ON Condition;
```

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# Join queries

## Sample database

CREATE TABLE statement

```
CREATE TABLE DEPARTMENT(
 name                VARCHAR(50)        NOT NULL,
 code                CHAR(5)            NOT NULL,
 total_staff_number  DECIMAL(2)         NOT NULL,
 chair               VARCHAR(50)            NULL,
 budget              DECIMAL(9,1)       NOT NULL,
  CONSTRAINT dept_pkey PRIMARY KEY(name),
  CONSTRAINT dept_ckey1 UNIQUE(code),
  CONSTRAINT dept_ckey2 UNIQUE(chair),
  CONSTRAINT dept_check1 CHECK (total_staff_number BETWEEN 1 AND 50) );
```

CREATE TABLE statement

```
CREATE TABLE COURSE(
 cnum                CHAR(7)            NOT NULL,
 title               VARCHAR(200)       NOT NULL,
 credits             DECIMAL(2)         NOT NULL,
 offered_by          VARCHAR(50)            NULL,
  CONSTRAINT course_pkey PRIMARY KEY(cnum),
  CONSTRAINT course_check1 CHECK (credits IN (6, 12)),
  CONSTRAINT course_fkey1 FOREIGN KEY(offered_by)
                        REFERENCES DEPARTMENT(name) ON DELETE CASCADE );
```

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# Join queries

Consider the following query: Find the titles of all courses offered by a department chaired by Peter

Relational schema

```
DEPARTMENT
name | code | total_staff_number | chair | budget
```

- There are no titles of courses in a relational table DEPARTMENT !
- The titles of courses are in a relational table COURSE

Relational schema

```
COURSE
cnum | title | credits | offered_by
```

- To implement the query we must use two tables: DEPARTMENT and COURSE
- The rows from a table DEPARTMENT must be joined with (connected to) the respective rows in a relational table COURSE over a condition DEPARTMENT.name = COURSE.offered_by

SELECT statement with JOIN operation

```
SELECT COURSE.title
FROM COURSE JOIN DEPARTMENT
            ON DEPARTMENT.name = COURSE.offered_by
WHERE DEPARTMENT.chair = 'Peter';
```

# Join queries

Implementation of the query Find the titles of all courses offered by a department chaired by Peter has the following syntactical variations

SELECT statement with JOIN operation

```
SELECT title
FROM COURSE JOIN DEPARTMENT
            ON name = offered_by
WHERE chair = 'Peter';
```

SELECT statement with JOIN operation

```
SELECT C.title
FROM COURSE C JOIN DEPARTMENT D
              ON D.name = C.offered_by
WHERE D.chair = 'Peter';
```

SELECT statement with JOIN operation

```
SELECT COURSE.title
FROM COURSE, DEPARTMENT
WHERE DEPARTMENT.name = COURSE.offered_by AND DEPARTMENT.chair = 'Peter';
```

SELECT statement with JOIN operation

```
SELECT title
FROM COURSE, DEPARTMENT
WHERE name = offered_by AND chair = 'Peter';
```

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# ANSI SQL Syntax

The following implementations of the query Find the titles of all courses offered by a department chaired by Peter are consistent with ANSI SQL standard

SELECT statement with JOIN operation (ANSI SQL standard)

```
SELECT COURSE.title
FROM COURSE JOIN DEPARTMENT
            ON DEPARTMENT.name = COURSE.offered_by
WHERE DEPARTMENT.chair = 'Peter';
```

SELECT statement with JOIN operation (ANSI SQL standard)

```
SELECT title
FROM COURSE JOIN DEPARTMENT
            ON name = offered_by
WHERE chair = 'Peter';
```

SELECT statement with JOIN operation (ANSI SQL standard)

```
SELECT C.title
FROM COURSE C JOIN DEPARTMENT D
              ON D.name = C.offered_by
WHERE D.chair = 'Peter';
```

# SELECT statement (3)

## Outline

Join queries

Natural join queries

Column name join queries

Cross join queries

Join queries over more than 2 tables

Self-join queries

# Natural join queries

Consider a query: Find the names of all employees from a department chaired by James Bond, that requires the following relational tables:

```
DEPARTMENT                                                    Relational schema
                        dname | code | total staff number | chair | budget
```

```
EMPLOYEE                                                      Relational schema
                        enum | ename | dname
```

A natural join query

```
                                                  SELECT statement with NATURAL JOIN operation
SELECT ename
FROM EMPLOYEE NATURAL JOIN DEPARTMENT
WHERE chair = 'James Bond';
```

- is equivalent to a join query

```
                                  SELECT statement with JOIN operation (equivalent to a statment above)
SELECT ename
FROM EMPLOYEE JOIN DEPARTMENT
              ON EMPLOYEE.dname = DEPARTMENT.dname
WHERE chair = 'James Bond';
```

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# Column name join queries

Consider a query: Find the names of all employees from a department chaired by James Bond, that requires the following relational tables:

```
DEPARTMENT                                                    Relational schema
                        dname | code | total staff number | chair | budget
```

```
EMPLOYEE                                                      Relational schema
                        enum | ename | dname
```

A column name join query

```
                                                  SELECT statement with column name JOIN operation
SELECT ename
FROM EMPLOYEE JOIN DEPARTMENT
              USING(dname)
WHERE chair = 'James Bond';
```

- is equivalent to a join query

```
                        SELECT statement with JOIN operation (equivalent to a statement above)
SELECT ename
FROM EMPLOYEE JOIN DEPARTMENT
              ON  EMPLOYEE.dname = DEPARTMENT.dname
WHERE chair = 'James Bond';
```

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# SELECT statement (3)

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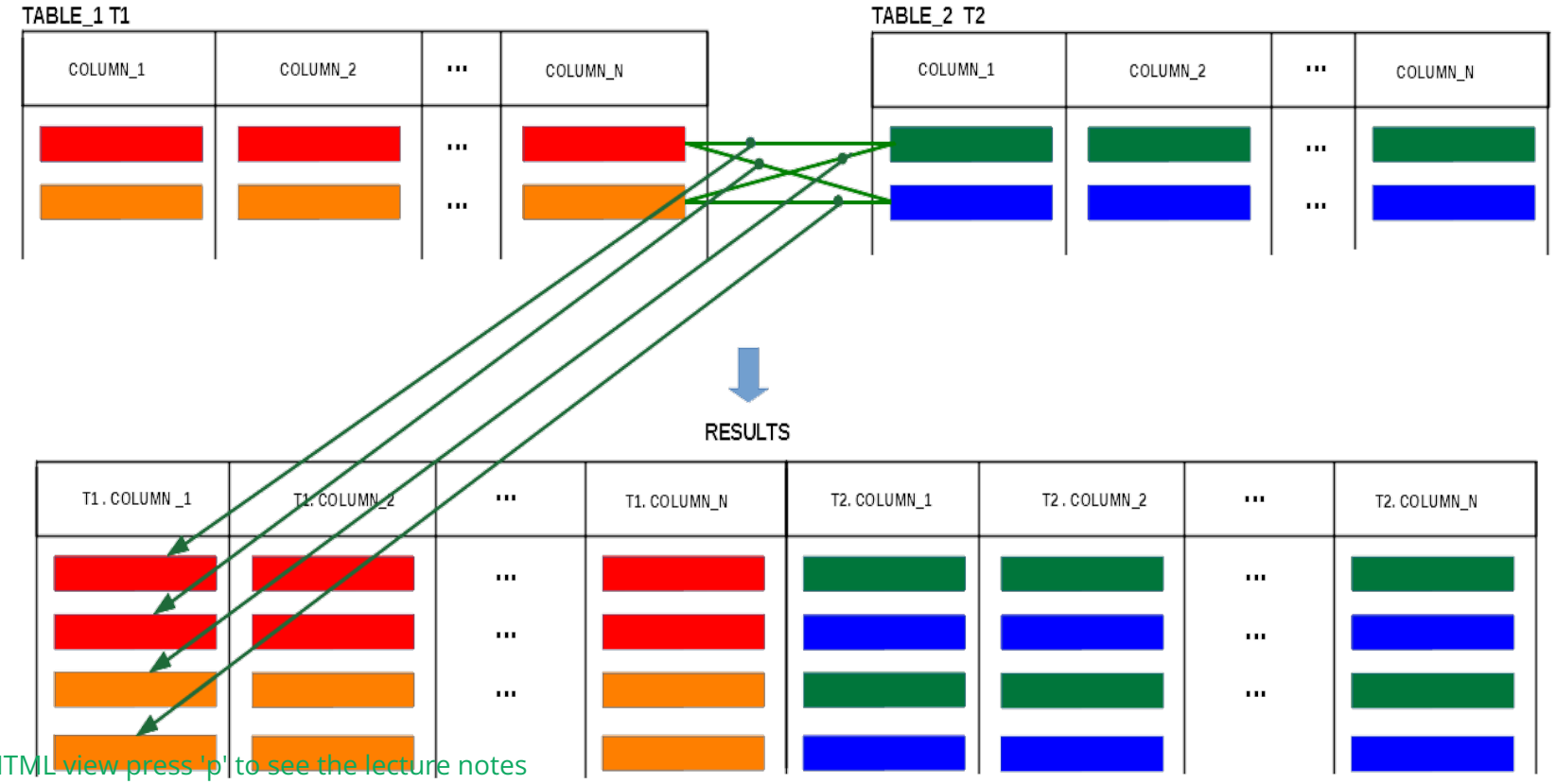
# Cross join queries

Cross join operation "connects" all rows from a relational table with all rows from another relational table

```
SELECT *
FROM TABLE_1  T1 CROSS JOIN TABLE_2 T2;
```

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# Cross join queries

Consider a query: Find all pairs of the names of employees and the names of chair people, that requires the following relational tables:

```
DEPARTMENT                                                    Relational schema
                        dname | code | total staff number | chair | budget
```

```
EMPLOYEE                                                      Relational schema
                        enum | ename | dname
```

A cross join query

```
                                                  SELECT statement with CROSS JOIN operations
SELECT ename, chair
FROM EMPLOYEE CROSS JOIN DEPARTMENT;
```

- is equivalent to the following join queries

```
                                                  SELECT statement equivalent to a statement above
SELECT ename, chair
FROM EMPLOYEE JOIN DEPARTMENT;
```

```
                                                  SELECT statement equivalent to a statement above
SELECT ename, chair
FROM EMPLOYEE, DEPARTMENT;
```

# SELECT statement (3)

## Outline

Join queries

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Column name join queries

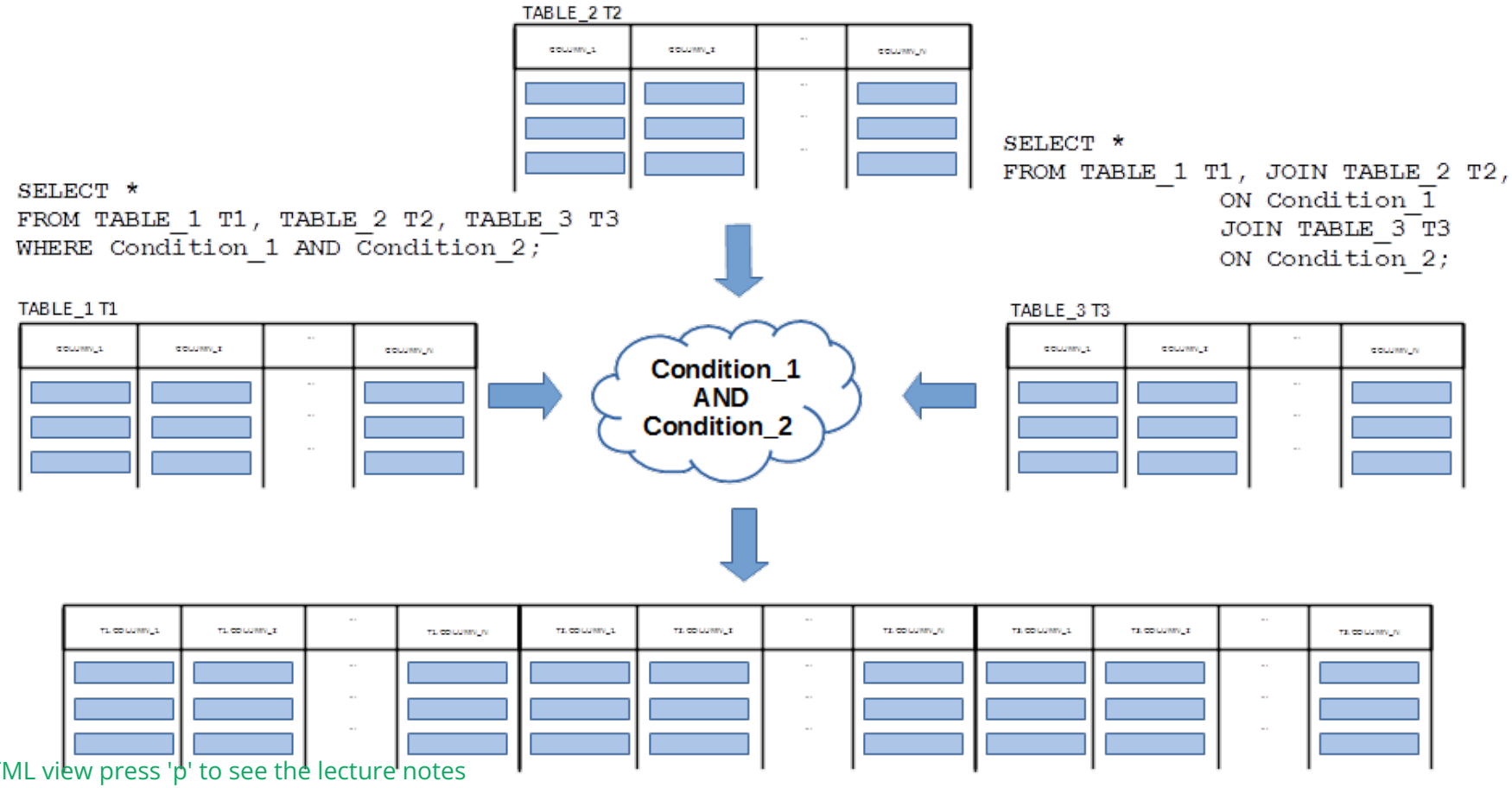
Cross join queries

Join queries over more than 2 tables

Self-join queries

# Join queries over more than 2 tables

A sample join of three relational tables `TABLE_1`, `TABLE_2`, and `TABLE_3`

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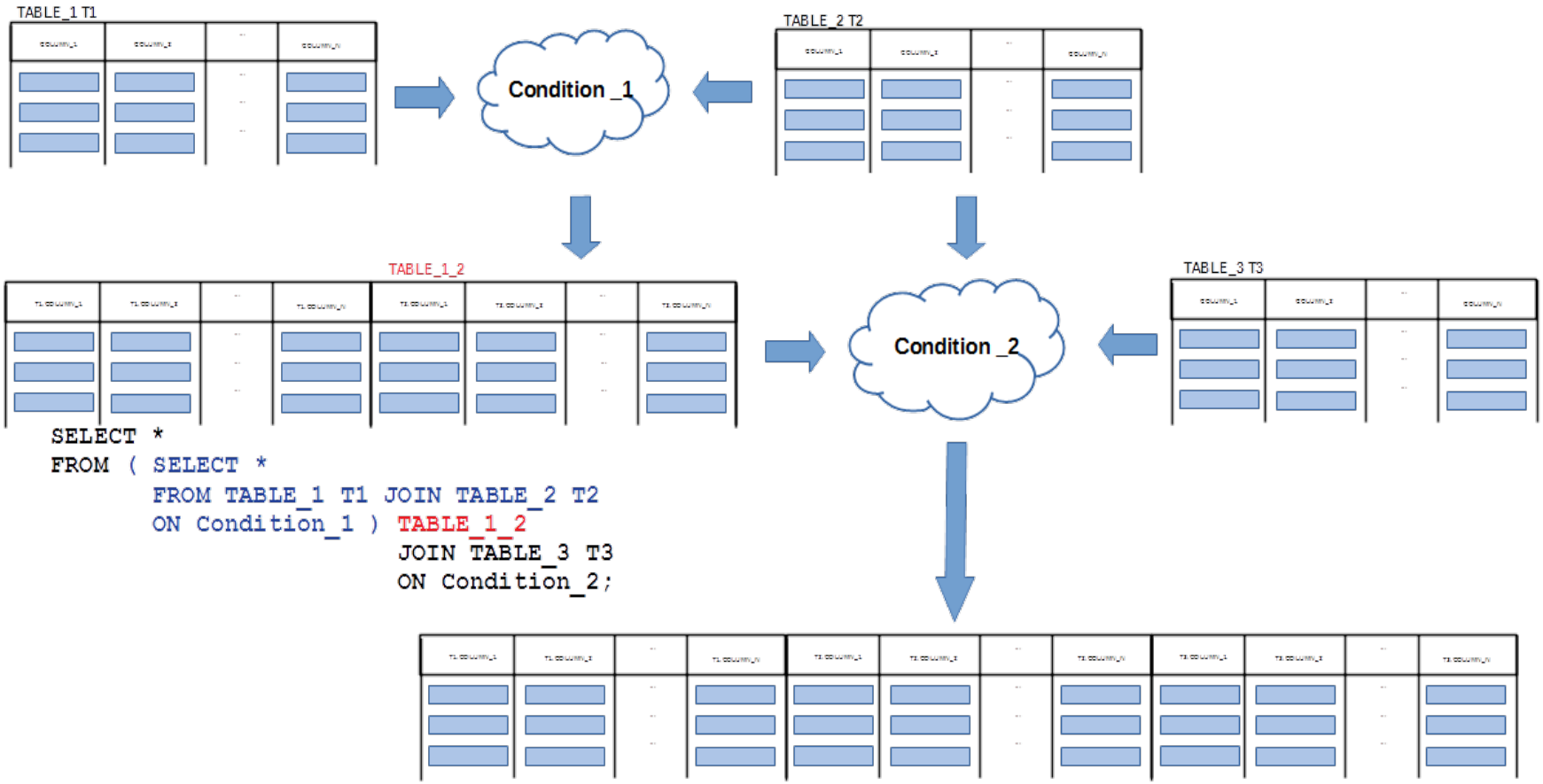
# Join queries over more than 2 tables

Application of inline view to simplify join of three relational tables `TABLE_1`, `TABLE_2`, and `TABLE_3`




```
SELECT *
FROM ( SELECT *
       FROM TABLE_1 T1 JOIN TABLE_2 T2
       ON Condition_1 ) TABLE_1_2
                        JOIN TABLE_3 T3
                        ON Condition_2;
```

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# Join queries over more than 2 tables

Consider the relational tables with the following schemas

Relational schema

```
COURSE
        cnum | title | credits
```

Relational schema

```
STUDENT
        snum | name | degree
```

Relational schema

```
ENROLMENT
        cnum | snum | edate | result
```

A query find the names of all students who enrolled Java course can be implemented as the following join query

SELECT statement that joins three relational tables

```
SELECT STUDENT.name
FROM COURSE JOIN ENROLMENT
            ON COURSE.cnum = ENROLMENT.cnum
            JOIN STUDENT
            ON ENROLMENT.snum = STUDENT.snum
WHERE COURSE.title = 'Java';
```

# Join queries over more than 2 tables

Implementation of a query find the names of all students who enrolled Java course has the following syntactical variations

SELECT statement that joins three relational tables

```
SELECT STUDENT.name
FROM COURSE JOIN ENROLMENT
            ON COURSE.cnum = ENROLMENT.cnum
            JOIN STUDENT
            ON ENROLMENT.snum = STUDENT.snum
WHERE COURSE.title = 'Java';
```

SELECT statement that joins three relational tables

```
SELECT STUDENT.name
FROM COURSE, ENROLMENT, STUDENT
WHERE COURSE.cnum = ENROLMENT.cnum AND ENROLMENT.snum = STUDENT.snum AND
       COURSE.title = 'Java';
```

SELECT statement that joins three relational tables

```
SELECT STUDENT.name
FROM ( SELECT *
       FROM COURSE JOIN ENROLMENT
                   ON COURSE.cnum = ENROLMENT.cnum
       WHERE COURSE.title = 'Java' ) CE JOIN STUDENT
                                        ON CE.snum = STUDENT.snum
WHERE COURSE.title = 'Java';
```

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# SELECT statement (3)

## Outline

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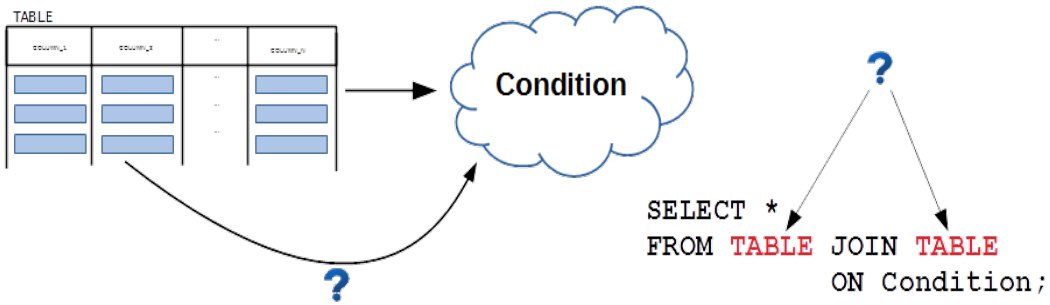
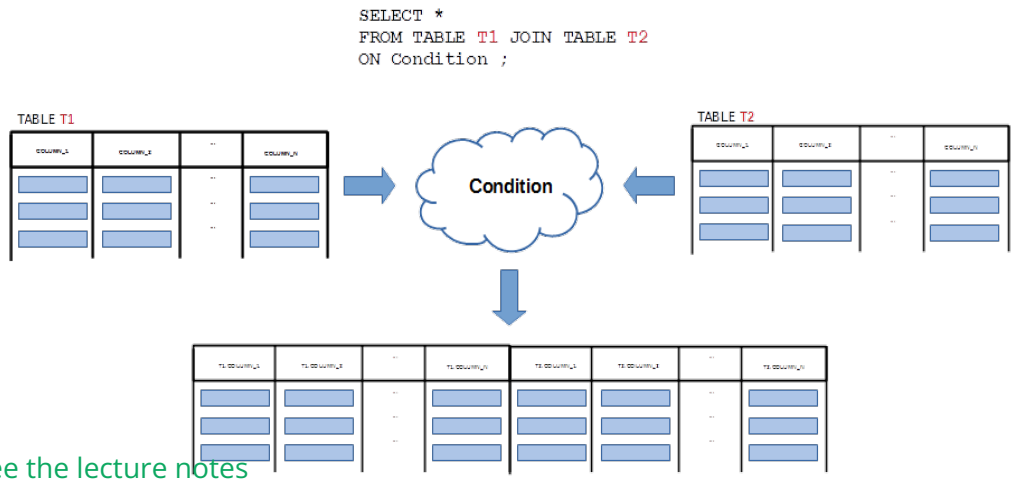
Self-join queries

# Self-join queries

What if a relational table must be joined with itself ?




A table, that must be joined with itself obtains two different alias names

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# Self-join queries

Consider a relational table with the following schema:

Relational schema

```
EMPLOYEE
        enum, name, manager
```

and the following contents:

Relational table

| enum | name | manager |
|---|---|---|
| 10 | John | NULL |
| 20 | Peter | 10 |
| 30 | Mary | 10 |
| 40 | Mike | 20 |
| 50 | Kate | 20 |
| 60 | Greg | 50 |
| 70 | Phil | 50 |

Consider a query find a name of manager of employee number 40

We can "plan" the implementation in the following way:

- (1) Find an employee number of manager of employee number 40
- (2) Find a name of employee found in the previous query

# Self-join queries

Implementation of a plan:

(1) Find employee number of manager of employee number 40

(2) Find a name of employee found in the previous query

is the following:

SELECT statement

```
SELECT manager
FROM EMPLOYEE
WHERE enum = 40;
```

Result

```
20
```

SELECT statement

```
SELECT name
FROM EMPLOYEE
WHERE enum = 20;
```

Result

```
Peter
```

Is it possible to implement the query as one `SELECT` statement ?

YES ! and it is possible to do it in more than one way !

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# Self-join queries

## Solution 1

Assume that we have two identical relational tables `E1` and `E2`

Relational tables

```
E1                                  E2
+------+-------+---------+          +------+-------+---------+
| enum | name  | manager |          | enum | name  | manager |
+------+-------+---------+          +------+-------+---------+
|   10 | John  |    NULL |          |   10 | John  |    NULL |
|   20 | Peter |      10 |    -------->|   20 | Peter |      10 |
|   30 | Mary  |      10 |    |     |   30 | Mary  |      10 |
|   40 | Mike  |      20 |-----     |   40 | Mike  |      20 |
|   50 | Kate  |      20 |          |   50 | Kate  |      20 |
|   60 | Greg  |      50 |          |   60 | Greg  |      50 |
|   70 | Phil  |      50 |          |   70 | Phil  |      50 |
+------+-------+---------+          +------+-------+---------+
```

To find a name of manager of employee number 40 we take a row

Row

```
|   40 | Mike  |      20 |
```

- from a table `E1` and we join over a condition `E1.manager = E2.enum` with a row

Row

```
|   20 | Peter |      10 |
```

- from a table `E2`

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# Self-join queries

So, how do we implement such "magic" ?

SELECT statement with self-join

```
SELECT E2.name
FROM EMPLOYEE E1 JOIN EMPLOYEE E2
                 ON E1.manager = E2.enum
WHERE E1.enum = 40;
```

Relational tables

```
E1                                  E2
+------+-------+---------+          +------+-------+---------+
| enum | name  | manager |          | enum | name  | manager |
+------+-------+---------+          +------+-------+---------+
|   10 | John  |    NULL |          |   10 | John  |    NULL |
|   20 | Peter |      10 |   -------->|   20 | Peter |      10 |
|   30 | Mary  |      10 |   |      |   30 | Mary  |      10 |
|   40 | Mike  |      20 |-----     |   40 | Mike  |      20 |
|   50 | Kate  |      20 |          |   50 | Kate  |      20 |
|   60 | Greg  |      50 |          |   60 | Greg  |      50 |
|   70 | Phil  |      50 |          |   70 | Phil  |      50 |
+------+-------+---------+          +------+-------+---------+
```

# Self-join queries

## Solution 2

We use inline views technique to combine the following queries

SELECT statement

```
SELECT manager
FROM EMPLOYEE
WHERE enum = 40;
```

SELECT statement

```
SELECT name
FROM EMPLOYEE
WHERE enum = 20;
```

We use the first `SELECT` statement to create an inline view `E40`

Inline view

```
( SELECT manager
FROM EMPLOYEE
WHERE enum = 40 ) E40
```

Then we join an inline view `E40` with a relational table `EMPLOYEE`

SELECT statement with inline view

```
SELECT EMPLOYEE.name
FROM EMPLOYEE JOIN ( SELECT manager
                     FROM EMPLOYEE
                     WHERE enum = 40 ) E40
              ON EMPLOYEE.enum = E40.manager;
```

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# Self-join queries

In another query we find the names of all employees directly managed by Kate

Relational table

| enum | name | manager |
|---|---|---|
| 10 | John | NULL |
| 20 | Peter | 10 |
| 30 | Mary | 10 |
| 40 | Mike | 20 |
| 50 | Kate | 20 |
| 60 | Greg | 50 |
| 70 | Phil | 50 |

We "plan" the implementation in the following way:

- (1) Find an employee number of an employee Kate
- (2) Find the names of employees who have a number found in the previous query in a column `manager`

# Self-join queries

## Solution 1

Assume that we have two identical relational tables `E1` and `E2`

Relational tables

```
E1                                  E2
+------+-------+---------+          +------+-------+---------+
| enum | name  | manager |          | enum | name  | manager |
+------+-------+---------+          +------+-------+---------+
|   10 | John  |    NULL |          |   10 | John  |    NULL |
|   20 | Peter |      10 |          |   20 | Peter |      10 |
|   30 | Mary  |      10 |          |   30 | Mary  |      10 |
|   40 | Mike  |      20 |          |   40 | Mike  |      20 |
|   50 | Kate  |      20 |    -------- |   50 | Kate  |      20 |
|   60 | Greg  |      50 |<---|     |   60 | Greg  |      50 |
|   70 | Phil  |      50 |<---|     |   70 | Phil  |      50 |
+------+-------+---------+          +------+-------+---------+
```

To find a number of employee Kate we take a row

Row

```
|   50 | Kate  |      20 |
```

- from a table `E2` and we join it over a condition `E2.enum = E1.manager` with the rows

Row

```
|   60 | Greg  |      50 |
```

Row

```
|   70 | Phil  |      50 |
```

- from a table `E1`

# Self-join queries

So, how do we implement such "magic" ?

SELECT statement with self-join

```
SELECT E1.name
FROM EMPLOYEE E1 JOIN EMPLOYEE E2
                 ON E1.manager = E2.enum
WHERE E2.name = 'Kate';
```

Relational tables

```
E1                                  E2
+------+-------+---------+          +------+-------+---------+
| enum | name  | manager |          | enum | name  | manager |
+------+-------+---------+          +------+-------+---------+
|   10 | John  |    NULL |          |   10 | John  |    NULL |
|   20 | Peter |      10 |          |   20 | Peter |      10 |
|   30 | Mary  |      10 |          |   30 | Mary  |      10 |
|   40 | Mike  |      20 |          |   40 | Mike  |      20 |
|   50 | Kate  |      20 |    -------- |   50 | Kate  |      20 |
|   60 | Greg  |      50 |<---|     |   60 | Greg  |      50 |
|   70 | Phil  |      50 |<---|     |   70 | Phil  |      50 |
+------+-------+---------+          +------+-------+---------+
```

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# Self-join queries

## Solution 2

We use inline views technique to combine the following queries

SELECT statement

```
SELECT enum
FROM EMPLOYEE
WHERE name = 'Kate';
```

SELECT statement

```
SELECT name
FROM EMPLOYEE
WHERE manager = 50;
```

We use the first SELECT statement to create an inline view KATE

Inline view

```
( SELECT enum
  FROM EMPLOYEE
  WHERE name = 'Kate' ) KATE
```

Then we join an inline view KATE with a relational table EMPLOYEE

SELECT statement with inline view

```
SELECT EMPLOYEE.name
FROM EMPLOYEE JOIN ( SELECT enum
                     FROM EMPLOYEE
                     WHERE name = 'Kate' ) KATE
              ON EMPLOYEE.manager = KATE.enum;
```

# References

C. Coronel, S. Morris, A. Basta, M. Zgola, Data Management and Security, Chapters 5, 7, Cengage Compose eBook, 2018, eBook: Data Management and Security, 1st Edition

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D. Darmawikarta, SQL for MySQL A Beginner's Tutorial, Chapter 6, pages 55 - 61 Brainy Software Inc. First Edition: June 2014

How to ... ? Cookbook, How to implement queries in SQL ? (Part 1), Recipe 5.4 How to implement simple join queries ?

How to ... ? Cookbook, How to implement queries in SQL ? (Part 2) Recipe 6.1 How to implement self join queries ?