KMITL
พระจอมเกล้าลาดกระบัง

KMITL GO
BEYOND THE LIMIT

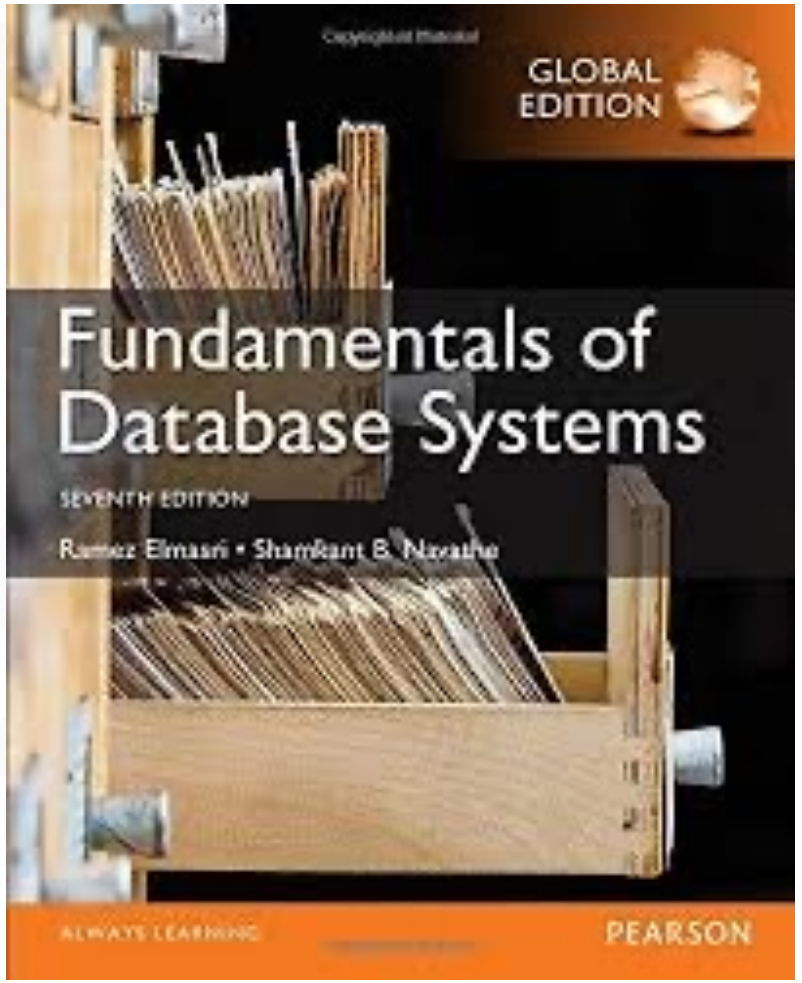
Database Systems

Program in Computer Engineering
Faculty of Engineering

King Mongkut's Institute of Technology Ladkrabang

Text

- Ramez Elmasri and Shamkant B. Navathe. "Fundamentals of Database Systems" 7th Edition., Pearson, 2017



Chapter 7

mobility โครงสร้างของมัน

More SQL: Complex Queries, Views, and Schema Modification

Outline

- More Complex SQL Retrieval Queries
- Views (Virtual Tables) in SQL
- Schema Modification in SQL

More Complex SQL Retrieval Queries

- Additional features allow users to specify more complex retrievals from database:
  - Nested queries,
  - joined tables, and outer joins (in the FROM clause),
  - aggregate functions, and
  - grouping

Comparisons Involving NULL and Three-Valued Logic

- Meanings of NULL
  - Unknown value ไม่รู้
  - Unavailable or withheld value ไม่มีข้อมูล
  - Not applicable attribute ข้อมูลไม่เกี่ยวข้อง เช่น สถานภาพสมรส (เขาไม่ได้แต่ก็ NULL ซิง)
- Each individual NULL value considered to be different from every other NULL value
- SQL uses a three-valued logic:
  - TRUE, FALSE, and UNKNOWN (like Maybe)
- NULL = NULL comparison is avoided

หัวมเปรียบเทียบ กัน

ทั้ง 2 ค่า True : True

ใดหนึ่ง True = True

ตรงข้ามกัน

Table 7.1 Logical Connectives in Three-Valued Logic

(a) AND	TRUE	FALSE	UNKNOWN
TRUE	TRUE	FALSE	UNKNOWN
FALSE	FALSE	FALSE	FALSE
UNKNOWN	UNKNOWN	FALSE	UNKNOWN

(b) OR	TRUE	FALSE	UNKNOWN
TRUE	TRUE	TRUE	TRUE
FALSE	TRUE	FALSE	UNKNOWN
UNKNOWN	TRUE	UNKNOWN	UNKNOWN

(c) NOT	
TRUE	FALSE
FALSE	TRUE
UNKNOWN	UNKNOWN

- SQL allows queries that check whether an attribute value is NULL
  - **IS** or **IS NOT NULL**

Check ว่าเป็น Null ไหม

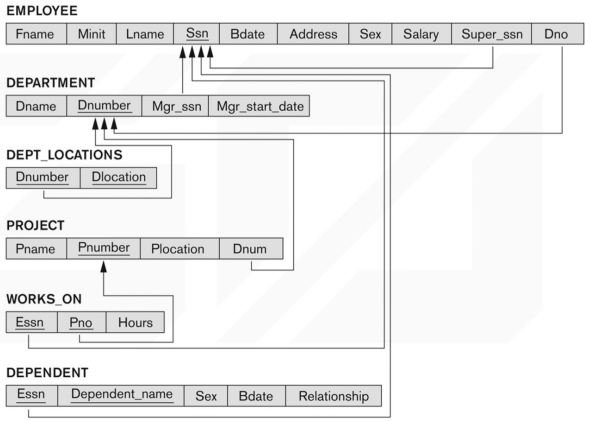
สิ่ง ที่ไม่มีหัวหน้า

Query 18. Retrieve the names of all employees who do not have supervisors.

```
Q18:    SELECT    Fname, Lname
        FROM      EMPLOYEE
        WHERE     Super_ssn IS NULL;
```

Nested Queries, Tuples, and Set/Multiset Comparisons

- Nested queries
  - Complete select-from-where blocks within WHERE clause of another query
  - **Outer query and nested subqueries**
- Comparison operator IN
  - Compares value *v* with a set (or multiset) of values *V*
  - Evaluates to TRUE if *v* is one of the elements in *V*




```
Q4A:  SELECT   DISTINCT Pnumber
      FROM     PROJECT
      WHERE    Pnumber IN
      ( SELECT   Pnumber
        FROM     PROJECT, DEPARTMENT, EMPLOYEE
        WHERE    Dnum=Dnumber AND
                 Mgr_ssn=Ssn AND Lname='Smith' )

      OR /UNION
      Pnumber IN
      ( SELECT   Pno
        FROM     WORKS_ON, EMPLOYEE
        WHERE    Essn=Ssn AND Lname='Smith' );
```

Select the project number of projects that have an employee with last name 'Smith' involved as **manager.**

Select the project number of projects that have an employee with last name 'Smith' involved as **worker.**

tuple values ได้

- Use tuples of values in comparisons
  - Place them within parentheses

```
SELECT    DISTINCT Essn
FROM      WORKS_ON
WHERE     (Pno, Hours) IN ( SELECT    Pno, Hours
                            FROM      WORKS_ON
                            WHERE     Essn='123456789' );
```

Select the ESSN of all employees who work the same (project, hours) combination on some project that employee 'John Smit' (whose SNN = '123456789') works on.

- Use other comparison operators to compare a single value *v*
  - = ANY (or = SOME) operator
    - Returns TRUE if the value *v* is equal to some value in the set *V* and is hence equivalent to IN
  - Other operators that can be combined with ANY (or SOME): >, >=, <, <=, and <>
  - ALL: value must exceed all values from nested query

```
SELECT   Lname, Fname
FROM     EMPLOYEE
WHERE    Salary > ALL ( SELECT   Salary
                        FROM     EMPLOYEE
                        WHERE    Dno=5 );
```

Return the name of employees whose salary is greater than the salary of all the employees in department 5.

- Avoid potential errors and ambiguities
  - Create tuple variables (aliases) for all tables referenced in SQL query

Query 16. Retrieve the name of each employee who has a dependent with the same first name and is the same sex as the employee.

```
Q16:  SELECT   E.Fname, E.Lname
      FROM     EMPLOYEE AS E
      WHERE    E.Ssn IN ( SELECT   Essn
                          FROM     DEPENDENT AS D
                          WHERE    E.Fname=D.Dependent_name
                                   AND E.Sex=D.Sex );
```

Correlated Nested Queries

เมื่อใช้ IN ก็เปลี่ยนเป็นใช้ AND ได้

- **Queries that are nested using the = or IN comparison operator** can be collapsed into one single block: E.g., Q16 can be written as:

Q16

```
SELECT   E.Fname, E.Lname
FROM     EMPLOYEE AS E
WHERE    E.Ssn IN ( SELECT   Essn
                    FROM     DEPENDENT AS D
                    WHERE    E.Fname=D.Dependent_name
                    AND E.Sex=D.Sex );
```

เมื่อใช้

```
Q16A:   SELECT   E.Fname, E.Lname
        FROM     EMPLOYEE AS E , DEPENDENT AS D
        WHERE    E.Ssn = D.Essn
        AND      E.Sex = D.Sex
        AND      E.Fname = D.Dependent_name;
```

- **Correlated** nested query (ความสัมพันธ์)
  - Evaluated once for each tuple in the outer query (ประเมินผล 1 ครั้ง ต่อ 1 tuple ของ outer query)

The EXISTS and UNIQUE Functions in SQL for correlating queries

- **EXISTS** function
  - Check whether the result of a correlated nested query is empty or not. They are Boolean functions that return a TRUE or FALSE result.
- **EXISTS** and **NOT EXISTS**
  - Typically used in conjunction with a correlated nested query
- SQL function **UNIQUE (Q)**
  - Returns TRUE if there are no duplicate tuples in the result of query Q

Q16B: Retrieve the name of each employee who has a dependent with the same first name and is the same sex as the employee.

```
SELECT   Fname, Lname
FROM     Employee  AS  E
WHERE    EXISTS    (   SELECT  *
                       FROM    DEPENDENT  AS  D
                       WHERE   E.Ssn = D.Essn  AND
                               E.Sex = D.Sex    AND
                               E.Firstname = D.Dependent_name    );
```

Q6: Retrieve the names of employees who have no dependents.

```
SELECT  Fname, Lname
FROM    Employee  AS  E
WHERE   NOT EXISTS  (  SELECT  *
                       FROM    DEPENDENT
                       WHERE   Ssn = Essn      );
```

มีคนชี้ชวน ถ้าอยากเรียน ลองศึกษาว่าคุ้มไหม อ่านอีกทีเข้าใจไหม

Q7: List the names of managers who have at least one dependent.

มีอยู่อย่างน้อย 1 คน

```
SELECT  Fname, Lname
FROM    Employee
WHERE   EXISTS  (       SELECT  *
                        FROM    DEPENDENT
                        WHERE   Ssn = Essn      )

        AND
        EXISTS
                (       SELECT  *
                        FROM    Department
                        WHERE   Ssn = Mgr_Ssn   )
```

Select all DEPENDENT tuples related to an EMPLOYEE

ที่ ssn ตรงกัน

Select all DEPARTMENT tuples managed by the EMPLOYEE

ที่ manager

```
SELECT  E.Fname, E.Lname , ALL DE , ALL D
FROM    EMPLOYE AS E, DEPENDENT AS DE, DEPARTMENT AS D
WHERE   E.Ssn = DE.Essn AND E.Ssn = D.Mgr-Ssn
```

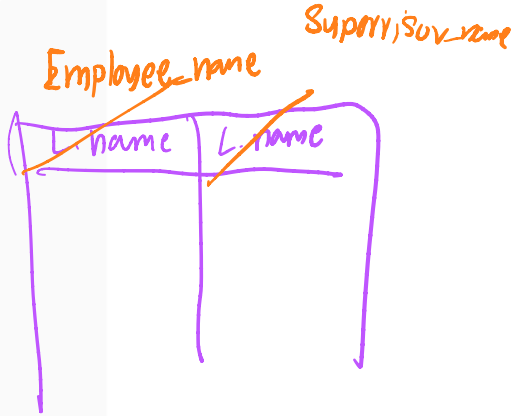
Explicit Sets and Renaming of Attributes in SQL

- Can use explicit set of values in WHERE clause

```
Q17:    SELECT    DISTINCT Essn
        FROM      WORKS_ON
        WHERE     Pno  IN  (1, 2, 3);
```

อยู่ใน 1 or 2 or 3 รวมทั้งหมด (1,2), (1,3), (2,3)

- Use qualifier AS followed by desired new name
  - Rename any attribute that appears in the result of a query




```
Q8A:    SELECT    E.Lname AS Employee_name, S.Lname AS Supervisor_name
        FROM      EMPLOYEE AS E, EMPLOYEE AS S
        WHERE     E.Super_ssn=S.Ssn;
```

Specifying Joined Tables in the FROM Clause of SQL

- **Joined table**
  - Permits users to specify a table resulting from a join operation in the FROM clause of a query
- The FROM clause in Q1A
  - Contains a single joined table.

    JOIN may also be called INNER JOIN

```
Q1A:    SELECT    Fname, Lname, Address
        FROM      (EMPLOYEE JOIN DEPARTMENT ON Dno=Dnumber)
        WHERE     Dname='Research';
```

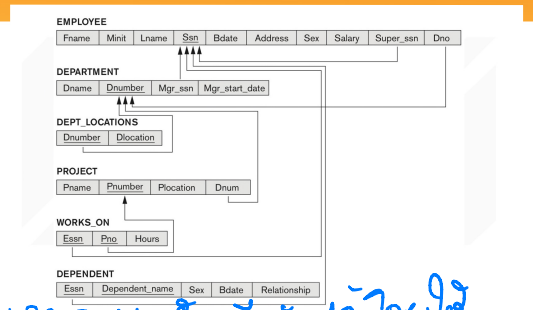
Different Types of JOINed Tables in SQL

- Specify different types of join
  - NATURAL JOIN
  - Various types of OUTER JOIN (LEFT, RIGHT, FULL)
- NATURAL JOIN on two relations R and S
  - No join condition specified
  - Is equivalent to an implicit EQUIJOIN condition for each pair of attributes with same name from R and S

มี join อื่นอีกด้วย
full join, left join, right join

Attribute เงื่อนไขในการ join กัน

NATURAL JOIN



- Rename attributes of one relation so it can be joined with another using NATURAL JOIN:

Q1B:
```
SELECT   Fname, Lname, Address
FROM     ( EMPLOYEE NATURAL JOIN
             ( DEPARTMENT AS
                 DEPT (Dname, Dno, Mssn, Msdate)  )  )
WHERE    Dname='Research';
```

The above works with EMPLOYEE.Dno = DEPT.Dno
as an implicit join condition

INNER and OUTER Joins

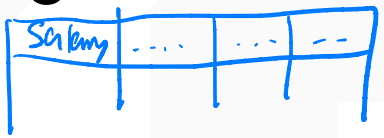
- INNER JOIN **(versus** OUTER JOIN)
  - Default type of join in a joined table
  - Tuple is included in the result only if a matching tuple exists in the other relation
- LEFT OUTER JOIN
  - Every tuple in left table must appear in result
  - If no matching tuple
    - Padded with NULL values for attributes of right table
- RIGHT OUTER JOIN
  - Every tuple in right table must appear in result
  - If no matching tuple
    - Padded with NULL values for attributes of left table

Aggregate Functions in SQL

- Used to summarize information from multiple tuples into a single-tuple summary
- Built-in aggregate functions
  - COUNT, SUM, MAX, MIN, and AVG
- **Grouping**
  - Create subgroups of tuples before summarizing
- To select entire groups, HAVING clause is used
- Aggregate functions can be used in the SELECT clause or in a HAVING clause

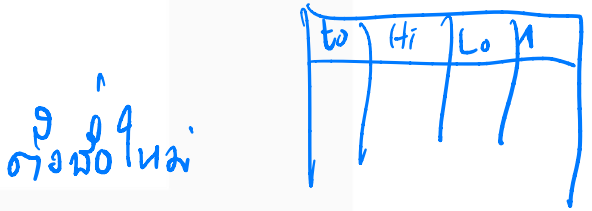
Renaming Results of Aggregation

- Following query returns a single row of computed values from EMPLOYEE table:



```
Q19:   SELECT   SUM (Salary), MAX (Salary), MIN (Salary), AVG  (Salary)
       FROM     EMPLOYEE;
```

- The result can be presented with new names:



```
Q19A:  SELECT   SUM (Salary)  AS Total_Sal,    MAX (Salary) AS Highest_Sal,
                MIN (Salary)  AS Lowest_Sal,   AVG (Salary)  AS Average_Sal
       FROM     EMPLOYEE;
```

เลย NULL ละไม่นับ ละ: ถ้ามีไปเลย

- NULL values are discarded when aggregate functions are applied to a particular column

Query 20. Find the sum of the salaries of all employees of the 'Research' department, as well as the maximum salary, the minimum salary, and the average salary in this department.

```
Q20:  SELECT  SUM (Salary), MAX (Salary), MIN (Salary), AVG (Salary)
      FROM    (EMPLOYEE JOIN DEPARTMENT ON Dno=Dnumber)
      WHERE   Dname='Research';
```

Queries 21 and 22. Retrieve the total number of employees in the company (Q21) and the number of employees in the 'Research' department (Q22).

```
Q21:  SELECT  COUNT (*)
      FROM    EMPLOYEE;

Q22:  SELECT  COUNT (*)
      FROM    EMPLOYEE, DEPARTMENT
      WHERE   DNO=DNUMBER AND DNAME='Research';
```

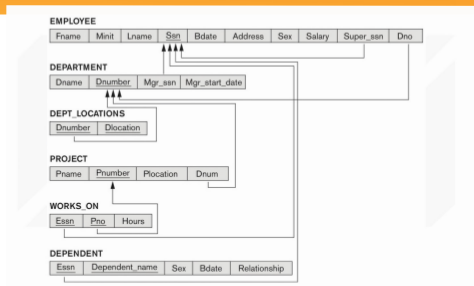
Aggregate Functions on Booleans

- SOME and ALL may be applied as functions on Boolean Values.
  - SOME returns true if at least one element in the collection is TRUE (similar to OR)
  - ALL returns true if all of the elements in the collection are TRUE (similar to AND)

Grouping: The GROUP BY Clause

- **Partition** relation into subsets of tuples
  - Based on **grouping attribute(s)**
  - Apply function to each such group independently
- `GROUP BY` clause
  - Specifies grouping attributes
- COUNT (*) counts the number of rows in the group

Examples of GROUP BY



- The grouping attribute must appear in the SELECT clause:

```
Q24:    SELECT      Dno, COUNT (*), AVG (Salary)
        FROM        EMPLOYEE
        GROUP BY    Dno;
```

Dno	Count พนักงาน	Salary
1	10	15,000
2	50	20,705
3	...	.....

- If the grouping attribute has NULL as a possible value, then a separate group is created for the null value (e.g., null Dno in the above query)
- GROUP BY may be applied to the result of a JOIN:

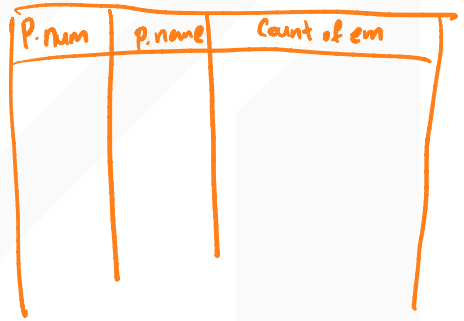
```
Q25:    SELECT      Pnumber, Pname, COUNT (*)
        FROM        PROJECT, WORKS_ON
        WHERE       Pnumber=Pno
        GROUP BY    Pnumber, Pname;
```

อีกแบบ ① → PROJECT JOIN WORK_ON ON Pnumber = Pno ② การทำงาน

P.numb	P.name	Count
1	~	10
2	~	20
3	~	30

- **HAVING** clause
  - Provides a condition to select or reject an entire group:

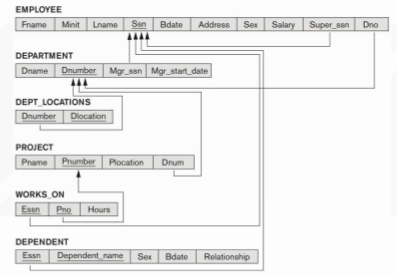
- **Query 26.** For each project *on which more than two employees work,* retrieve the project number, the project name, and the number of employees who work on the project.



Q26:

```
SELECT      Pnumber, Pname, COUNT (*)
FROM        PROJECT, WORKS_ON
WHERE       Pnumber=Pno
GROUP BY    Pnumber, Pname
HAVING      COUNT (*) > 2;
```

where / เงื่อนไขของกลุ่ม



project

work_on

non HAVING

Pname	Pnumber	...	Essn	Pno	Hours
ProductX	1		123456789	1	32.5
ProductX	1		453453453	1	20.0
ProductY	2		123456789	2	7.5
ProductY	2		453453453	2	20.0
ProductY	2		333445555	2	10.0
ProductZ	3		666884444	3	40.0
ProductZ	3		333445555	3	10.0
Computerization	10	...	333445555	10	10.0
Computerization	10		999887777	10	10.0
Computerization	10		987987987	10	35.0
Reorganization	20		333445555	20	10.0
Reorganization	20		987654321	20	15.0
Reorganization	20		888665555	20	NULL
Newbenefits	30		987987987	30	5.0
Newbenefits	30		987654321	30	20.0
Newbenefits	30		999887777	30	30.0

These groups are not selected by the HAVING condition of Q26.

After applying the WHERE clause but before applying HAVING

หลัง HAVING

Pname	Pnumber	...	Essn	Pno	Hours
ProductY	2		123456789	2	7.5
ProductY	2		453453453	2	20.0
ProductY	2		333445555	2	10.0
Computerization	10		333445555	10	10.0
Computerization	10	...	999887777	10	10.0
Computerization	10		987987987	10	35.0
Reorganization	20		333445555	20	10.0
Reorganization	20		987654321	20	15.0
Reorganization	20		888665555	20	NULL
Newbenefits	30		987987987	30	5.0
Newbenefits	30		987654321	30	20.0
Newbenefits	30		999887777	30	30.0

After applying the HAVING clause condition

Pname	Count (*)
ProductY	3
Computerization	3
Reorganization	3
Newbenefits	3

Result of Q26
(Pnumber not shown)

Combining the WHERE and the HAVING Clause

- Consider the query: we want to count the *total* number of employees whose salaries exceed $40,000 in each department, but only for departments where more than five employees work.

- **INCORRECT QUERY:**

```
SELECT    Dno, COUNT (*)
FROM      EMPLOYEE
WHERE     Salary > 40000
GROUP BY  Dno
HAVING    COUNT (*) > 5;
```

Correct Specification of the Query:

- Note: the WHERE clause applies tuple by tuple whereas HAVING applies to entire group of tuples

Query 28. For each department that has more than five employees, retrieve the department number and the number of its employees who are making more than $40,000.

```
Q28:  SELECT   Dnumber, COUNT (*)
      FROM     DEPARTMENT, EMPLOYEE
      WHERE    Dnumber=Dno AND Salary>40000 AND
               ( SELECT     Dno
                 FROM       EMPLOYEE
                 GROUP BY Dno
                 HAVING     COUNT (*) > 5)
```

(1) query ตารางที่อยู่ในวงเล็บก่อน คือ department ไหน มี 5 คน

EXPANDED Block Structure of SQL Queries

คำสั่ง SQL

```
SELECT <attribute and function list>
FROM <table list>
[ WHERE <condition> ]
[ GROUP BY <grouping attribute(s)> ]
[ HAVING <group condition> ]
[ ORDER BY <attribute list> ];
```

Views (Virtual Tables) in SQL

สร้างมา ภายใต้ เงื่อนไขใดหนึ่ง

- Concept of a view in SQL
  - Single table derived from other tables called the **defining tables**
  - Considered to be a virtual table that is not necessarily populated

Specification of Views in SQL

สร้าง view

- **CREATE VIEW** command

  มีหลักการ: { - ใช้ดูเฉพาะ group ของ App ได้
  - ~~~ ของ user ได้
  - ~~~ version ของ SW ได้

  - Give table name, list of attribute names, and a query to specify the contents of the view
  - In V1, attributes retain the names from base tables. In V2, attributes are assigned names

```
V1:     CREATE VIEW   WORKS_ON1   ← ผลลัพธ์จะเป็น table ใหม่ ชื่อ "WORK_ON1"
เหมือนเท่ากับอันนี้ AS SELECT     Fname, Lname, Pname, Hours
            FROM      EMPLOYEE, PROJECT, WORKS_ON
            WHERE     Ssn=Essn AND Pno=Pnumber;

V2:     CREATE VIEW   DEPT_INFO(Dept_name, No_of_emps, Total_sal)
        AS SELECT     Dname, COUNT (*), SUM (Salary)
            FROM      DEPARTMENT, EMPLOYEE
            WHERE     Dnumber=Dno
            GROUP BY  Dname;
```

ตัวอย่าง view

- Once a View is defined, SQL queries can use the View relation in the FROM clause
- View is always up-to-date
  - Responsibility of the DBMS and not the user
- `DROP VIEW` command ตัวอย่าง
  - Dispose of a view

View Implementation, View Update, and Inline Views

- Complex problem of efficiently implementing a view for querying
- **Strategy1: Query modification** approach
  - Compute the view as and when needed. Do not store permanently
  - Modify view query into a query on underlying base tables
  - **Disadvantage**: inefficient for views defined via complex queries that are time-consuming to execute

ใช้พื้นที่มากขึ้นแต่ทำให้ทำงานเร็วขึ้น

- **Strategy 2: View materialization**
  - Physically create a temporary view table when the view is first queried
  - Keep that table on the assumption that other queries on the view will follow
  - Requires efficient strategy for automatically updating the view table when the base tables are updated
- **Incremental update strategy for materialized views**
  - DBMS determines what new tuples must be inserted, deleted, or modified in a materialized view table

ข้อเสีย ที่เกิดจาก query → มีขั้นตอนซับซ้อน อีกที่อยู่ที่ base, กับ view

ใช้ view สร้างแล้วให้ ลักษณะ ข. คือขึ้นมา

เก็บ table ของ view ว่า follow

ถ้ามีการอัปเดต ล.? ว่าอัปเดตอันไหนบ้าง ต้อง base มีการ update

- Multiple ways to handle materialization:
  - **immediate update** strategy updates a view as soon as the base tables are changed
  - **lazy update** strategy updates the view when needed by a view query
  - **periodic update** strategy updates the view periodically (in the latter strategy, a view query may get a result that is not up-to-date). This is commonly used in Banks, Retail store operations, etc.

View Update

- Update on a view defined on a single table without any aggregate functions
  - Can be mapped to an update on underlying base table?
  - possible if the primary key is preserved in the view
- Update not permitted on aggregate views. E.g.,

```
V2:   CREATE VIEW   DEPT_INFO(Dept_name, No_of_emps, Total_sal)
      AS SELECT     Dname, COUNT (*), SUM (Salary)
          FROM      DEPARTMENT, EMPLOYEE
          WHERE     Dnumber=Dno
          GROUP BY  Dname;
```

```
UV2:  UPDATE    DEPT_INFO
      SET       Total_sal=100000
      WHERE     Dname='Research';
```

cannot be processed because Total_sal is a computed value in the view definition

- View involving joins
  - Often not possible for DBMS to determine which of the updates is intended
- Clause **WITH CHECK OPTION**
  - Must be added at the end of the view definition if a view is to be updated to make sure that tuples being updated stay in the view

Views as authorization mechanism

(การอนุญาต)

- SQL query authorization statements (GRANT and REVOKE) are described in detail in Chapter 30
- Views can be used to hide certain attributes or tuples from unauthorized users
- E.g., For a user who is only allowed to see employee information for those who work for department 5, he may only access the view DEPT5EMP:

```
CREATE VIEW   DEPT5EMP  AS
SELECT        *
FROM          EMPLOYEE
WHERE         Dno = 5;
```

Schema Change Statements in SQL

- **Schema evolution commands**
  - DBA may want to change the schema while the database is operational
  - Does not require recompilation of the database schema

The DROP Command

- **DROP** command
  - Used to drop named schema elements, such as tables, domains, or constraint
- Drop behavior options:
  - CASCADE and RESTRICT
- Example:
  - DROP SCHEMA COMPANY CASCADE;
  - This removes the schema and all its elements including tables, views, constraints, etc.

The ALTER table command

เปลี่ยน

- **Alter table actions** include:
  - Adding or dropping a column (attribute)
  - Changing a column definition
  - Adding or dropping table constraints
- Example:
  - `ALTER TABLE COMPANY.EMPLOYEE ADD COLUMN Job VARCHAR(12);`

เพิ่ม ที่ชื่อว่า Job

Adding and Dropping Constraints

- Change constraints specified on a table
  - Add or drop a named constraint

```
ALTER TABLE COMPANY.EMPLOYEE
DROP CONSTRAINT EMPSUPERFK CASCADE;
```

Dropping Columns, Default Values

- To drop a column
  - Choose either `CASCADE` or `RESTRICT`
  - `CASCADE` would drop the column from views etc.
    `RESTRICT` is possible if no views refer to it.

    ADD

    ALTER TABLE COMPANY.EMPLOYEE **DROP COLUMN** Address **CASCADE**;
- Default values can be dropped and altered :

  ALTER TABLE COMPANY.DEPARTMENT **ALTER COLUMN** Mgr_ssn **DROP DEFAULT**;

  ALTER TABLE COMPANY.DEPARTMENT **ALTER COLUMN** Mgr_ssn **SET DEFAULT** '333445555';

Table 7.2 Summary of SQL Syntax

สรุปทั้งหมด

Table 7.2 Summary of SQL Syntax

```
CREATE TABLE <table name> ( <column name> <column type> [ <attribute constraint> ]
                            { , <column name> <column type> [ <attribute constraint> ] }
                            [ <table constraint> { , <table constraint> } ] )

DROP TABLE <table name>
ALTER TABLE <table name> ADD <column name> <column type>

SELECT [ DISTINCT ] <attribute list>
FROM ( <table name> { <alias> } | <joined table> ) { , ( <table name> { <alias> } | <joined table> ) }
[ WHERE <condition> ]
[ GROUP BY <grouping attributes> [ HAVING <group selection condition> ] ]
[ ORDER BY <column name> [ <order> ] { , <column name> [ <order> ] } ]

<attribute list> ::= ( * | ( <column name> | <function> ( ( [ DISTINCT ] <column name> | * ) ) )
                       { , ( <column name> | <function> ( ( [ DISTINCT] <column name> | * ) ) } ) )

<grouping attributes> ::= <column name> { , <column name> }

<order> ::= ( ASC | DESC )

INSERT INTO <table name> [ ( <column name> { , <column name> } ) ]
( VALUES ( <constant value> , { <constant value> } ) { , ( <constant value> { , <constant value> } ) }
| <select statement> )
```

Table 7.2 Summary of SQL Syntax

DELETE FROM <table name> [WHERE <selection condition>]
UPDATE <table name> SET <column name> = <value expression> { , <column name> = <value expression> } [WHERE <selection condition>]
CREATE [UNIQUE] INDEX <index name> ON <table name> (<column name> [<order>] { , <column name> [<order>] }) [CLUSTER]
DROP INDEX <index name>
CREATE VIEW <view name> [(<column name> { , <column name> })] AS <select statement>
DROP VIEW <view name>

NOTE: The commands for creating and dropping indexes are not part of standard SQL.

Summary

- Complex SQL:
  - Nested queries, joined tables (in the FROM clause), outer joins, aggregate functions, grouping
- `CREATE VIEW` statement and materialization strategies
- Schema Modification for the DBAs using `ALTER TABLE` , `ADD and DROP COLUMN, ALTER CONSTRAINT` etc.