

Relational databases: usage principles

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# Database Structuring and Querying with SQL

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- Structured Query Language
- A standard language designed for managing data held in a relational database management system (RDBMS).
- Very highlevel language for querying and manipulating data.
- Helps in defining the structure of the data, modifying the data and specifying the security constraints.
- Uses a combination of relational algebra and relational calculus constructs.

- SQL keywords are case-insensitive, however, they are often written in uppercase.  
Same: SELECT, Select, select  
Same: City, city
- Values are case-sensitive.  
Different: 'Paris', 'paris'
- Some database systems require a semicolon at the end of each SQL statement.
- Each clause in a statement begin on a new line.

```
SELECT *  
FROM Capitals  
WHERE name='Paris' ;
```

- A relation or table is a multiset of tuples having the attributes specified by the schema.
- An attribute (or column) is a typed data entry present in each tuple in the relation.
- A tuple (or row) is a single entry in the table having the attributes. Also referred to sometimes as a **record** specified by the schema.

- Numbers: INT, SMALLINT, BIGINT, FLOAT
- Characters: CHAR(20), VARCHAR(50)
- Others: MONEY, DATETIME, ...

- The schema of a table is the table name, its attributes, and their types.
- A key is an attribute whose values are unique; we underline a key.

Building (id:float, name:string, address:string)

SQL is a:

- Data Definition Language (DDL)  
Define relational schema.  
Create/alter/delete tables and their attributes.
- Data Manipulation Language (DML)  
Insert/delete/modify tuples in tables.  
Query one or more tables.

- SELECT, FROM, WHERE
- ORDER BY
- DISTINCT, AND, OR, NOT, LIKE
- JOINS



# SELECT ... FROM

The operation of producing an output table that have a subset of the prior attributes.

```
SELECT <attributes >  
FROM <relations>;
```

To select all the fields available in the table:

```
SELECT *  
FROM <relations>;
```

# SELECT ... FROM

```
SELECT id, surface, level  
FROM Apartment;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	surface	level
102	200	2
103	50	5
104	75	3
200	150	0
201	250	1
202	250	2

To eliminate duplicates:

```
SELECT DISTINCT <attributes>  
FROM <relations>;
```

# DISTINCT

```
SELECT idBuilding  
FROM Apartment;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

idBuilding
1
1
1
2
2
2

# DISTINCT

```
SELECT DISTINCT idBuilding  
FROM Apartment;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

idBuilding
1
2

# WHERE

The operation of filtering a relation's tuples on some condition.

```
SELECT <attributes>  
FROM <relations>  
WHERE <conditions>;
```

WHERE clause is not only used in SELECT statements, it is also used in UPDATE, DELETE, ...

# WHERE

```
SELECT *  
FROM Apartment  
WHERE level = 2;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	no	surface	level	idBuilding
102	51	200	2	1
202	3	250	2	2

To filter records based on more than one condition:

```
WHERE NOT condition;  
WHERE condition1 AND condition2;  
WHERE condition1 OR condition2;
```

- AND operator displays a record if all the conditions separated by AND are TRUE.
- OR operator displays a record if any of the conditions separated by OR is TRUE.
- NOT operator displays a record if the condition(s) is NOT TRUE.



# AND

```
SELECT *  
FROM Apartment  
WHERE idBuilding = 1 AND surface > 60;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	no	surface	level	idBuilding
102	51	200	2	1
104	43	75	3	1

```
SELECT *
FROM Apartment
WHERE idBuilding = 1 OR surface > 60;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

```
SELECT *
FROM Apartment
WHERE NOT idBuilding = 1;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	no	surface	level	idBuilding
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2



# LIKE

```
SELECT *  
FROM Building  
WHERE address LIKE '%Grand%';
```

id	name	address
1	Koudalou	3 rue des Martyrs
2	Barabas	2 allée du Grand Turc

Building

id	name	address
2	Barabas	2 allée du Grand Turc

## Sorting the Results

```
SELECT <attributes>  
FROM <relations>  
ORDER BY <attributes>;
```

For descending order:

```
SELECT <attributes>  
FROM <relations>  
ORDER BY <attributes> DESC;
```

# ORDER BY

```
SELECT *  
FROM Apartment  
ORDER BY surface;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	no	surface	level	idBuilding
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
102	51	200	2	1
201	2	250	1	2
202	3	250	2	2

# ORDER BY

```
SELECT *  
FROM Apartment  
ORDER BY no DESC;
```

id	no	surface	level	idBuilding
102	51	200	2	1
103	52	50	5	1
104	43	75	3	1
200	1	150	0	2
201	2	250	1	2
202	3	250	2	2

Apartment

id	no	surface	level	idBuilding
103	52	50	5	1
102	51	200	2	1
104	43	75	3	1
202	3	250	2	2
201	2	250	1	2
200	1	150	0	2



# Cartesian product

```
SELECT *  
FROM <relation1, relation2, ...>;
```

# Cartesian product

```
SELECT *  
FROM  $\mathcal{R}_1$ ,  $\mathcal{R}_2$ ;
```

A	B
a	b
x	y

$\mathcal{R}_1$

C	D
c	d
u	v
x	y

$\mathcal{R}_2$

A	B	C	D
a	b	c	d
a	b	u	v
a	b	x	y
x	y	c	d
x	y	u	v
x	y	x	y

$\mathcal{R}_1 \times \mathcal{R}_2$

# INNER JOIN

Returns records that have matching values in both tables.

```
SELECT <attributes>  
FROM <relation1>  
INNER JOIN <relation2>  
ON <condition>;
```

Example:

```
SELECT *  
FROM Capitals  
INNER JOIN Presidents  
ON Capitals.State = Presidents.State;
```

# INNER JOIN

Capital	State
Paris	France
Madrid	Spain
Berlin	Germany

Capitals

State	President
France	Emmanuel Macron
Germany	Frank-Walter Steinmeier
Italy	Sergio Mattarella

Presidents

Capital	State	President
Paris	France	Emmanuel Macron
Berlin	Germany	Frank-Walter Steinmeier

Capitals ⋈ Presidents

# LEFT JOIN

Returns all records from the left table, and the matched records from the right table.

```
SELECT <attributes>  
FROM <relation1>  
LEFT JOIN <relation2>  
ON <condition>;
```

Example:

```
SELECT *  
FROM Capitals  
LEFT JOIN Presidents  
ON Capitals.State = Presidents.State;
```

# LEFT JOIN

Capital	State
Paris	France
Madrid	Spain
Berlin	Germany

Capitals

State	President
France	Emmanuel Macron
Germany	Frank-Walter Steinmeier
Italy	Sergio Mattarella

Presidents

Capital	State	President
Paris	France	Emmanuel Macron
Madrid	Spain	NULL
Berlin	Germany	Frank-Walter Steinmeier

Capitals ⋈ Presidents

# RIGHT JOIN

Returns all records from the right table, and the matched records from the left table.

```
SELECT <attributes>  
FROM <relation1>  
RIGHT JOIN <relation2>  
ON <condition>;
```

Example:

```
SELECT *  
FROM Capitals  
RIGHT JOIN Presidents  
ON Capitals.State = Presidents.State;
```

# RIGHT JOIN

Capital	State
Paris	France
Madrid	Spain
Berlin	Germany

Capitals

State	President
France	Emmanuel Macron
Germany	Frank-Walter Steinmeier
Italy	Sergio Mattarella

Presidents

Capital	State	President
Paris	France	Emmanuel Macron
Berlin	Germany	Frank-Walter Steinmeier
NULL	Italy	Sergio Mattarella

Capitals  $\bowtie$  Presidents





# FULL OUTER JOIN

Capital	State
Paris	France
Madrid	Spain
Berlin	Germany

Capitals

State	President
France	Emmanuel Macron
Germany	Frank-Walter Steinmeier
Italy	Sergio Mattarella

Presidents

Capital	State	President
Paris	France	Emmanuel Macron
Madrid	Spain	NULL
Berlin	Germany	Frank-Walter Steinmeier
NULL	Italy	Sergio Mattarella

Capitals ⋈ Presidents

- Creating, deleting, altering a table (schema object).
- Inserting, deleting, updating values (schema instance).

# Creating a table

```
CREATE TABLE  $\mathcal{R}$ (  
     $A_1D_1$  ,  
     $A_2D_2$  ,  
    ... ,  
     $A_nD_n$   
);
```

- Each  $A_i$  represents an attribute in the schema of relation  $\mathcal{R}$ .
- Each  $D_i$  denotes the data type of values in the domain for the corresponding attribute  $A_i$ .

# Creating a table

```
CREATE TABLE Apartment (  
    id int,  
    no int,  
    surface float,  
    level int,  
    idBuilding int  
);
```

id	no	surface	level	idBuilding

# Deleting a table

To delete (drop) an existing table:

```
DROP TABLE  $\mathcal{R}$ ;
```

Example

```
DROP TABLE Apartment;
```

A typical SQL query for altering:

```
ALTER TABLE  $\mathcal{R}$  <action> <description>;
```

- action: ADD, MODIFY, DROP, RENAME.
- description: the modification command associated with action.

# Altering a table

A typical SQL query for altering a table by adding attributes:

```
ALTER TABLE  $\mathcal{R}$  ADD  $A_i$   $D_i$  ;
```

Example:

```
ALTER TABLE Apartment ADD street varchar(255);
```

id	no	surface	level	idBuilding	street



# Altering a table

A typical SQL query for altering a table by deleting attributes:

```
ALTER TABLE  $\mathcal{R}$  DROP COLUMN  $A_i$ ;
```

Example:

```
ALTER TABLE Apartment DROP COLUMN level;
```

id	no	surface	idBuilding	street

# Inserting values

```
INSERT INTO  $\mathcal{R}(A_1, A_2, \dots)$   
VALUES ( $value_1, value_2, \dots$ );
```

Or:

```
INSERT INTO  $\mathcal{R}$   
VALUES ( $value_1, value_2, \dots, value_k$ );
```

- Each  $A_i$  represents an attribute in the schema of relation  $\mathcal{R}$ .
- Each  $value_i$  denotes the value for the corresponding attribute  $A_i$ .

# Inserting values

```
INSERT INTO Apartment(id, no, surface, level, idBuilding)  
VALUES ( 100, 1, 150, 14 , 1);
```

```
INSERT INTO Apartment  
VALUES ( 101, 34, 50, 15 , 1);
```

id	no	surface	level	idBuilding

id	no	surface	level	idBuilding
100	1	150	14	1
101	34	50	15	1

```
DELETE FROM  $\mathcal{R}$   
WHERE <condition>;
```

- WHERE clause specifies which record(s) should be deleted.

# Deleting values

```
DELETE FROM Apartment  
WHERE id = 101;
```

id	no	surface	level	idBuilding
100	1	150	14	1
101	34	50	15	1

id	no	surface	level	idBuilding
100	1	150	14	1

```
UPDATE  $\mathcal{R}$   
SET  $A_1 = value_1, A_2 = value_2, \dots$   
WHERE <condition>;
```

- Each  $A_i$  represents an attribute in the schema of relation  $\mathcal{R}$ .
- Each  $value_i$  denotes the value for the corresponding attribute  $A_i$ .
- WHERE clause specifies which record(s) should be updated.



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