Databases Design. Introduction to SQL

LECTURE 8

Relational algebra

IITU, ALMATY

SELECT

SQL allows to query data with SELECT command.

- Basic syntax:

```
SELECT attribute(s)
FROM table(s)
[WHERE selection condition(s)];
```

Join

- The **join** operation enables querying information from two or more related tables.

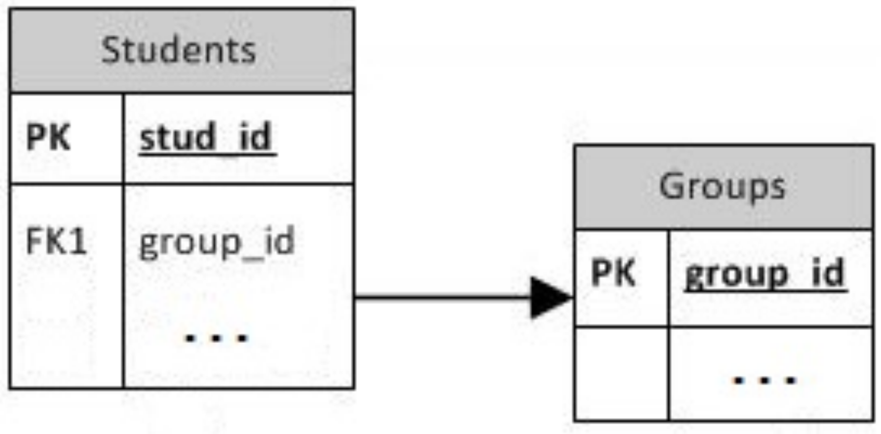
- It is similar to a selection condition except that values in two different tables are compared.

- The most common form of a join is an **equi-join**. An equi-join combines two or more tables based on the tables' Primary and Foreign keys.

Join: example 1

```
CREATE TABLE Groups(
group_id int PRIMARY KEY,
group_name varchar(15));

CREATE TABLE Students(
stud_id int PRIMARY KEY,
first_name varchar(20),
last_name varchar(20),
group_id int REFERENCES Groups(group_id));
```



Join: example 1

```sql
SELECT stud_id, last_name, group_name
FROM Students, Groups
WHERE Students.group_id = Groups.group_id;
```

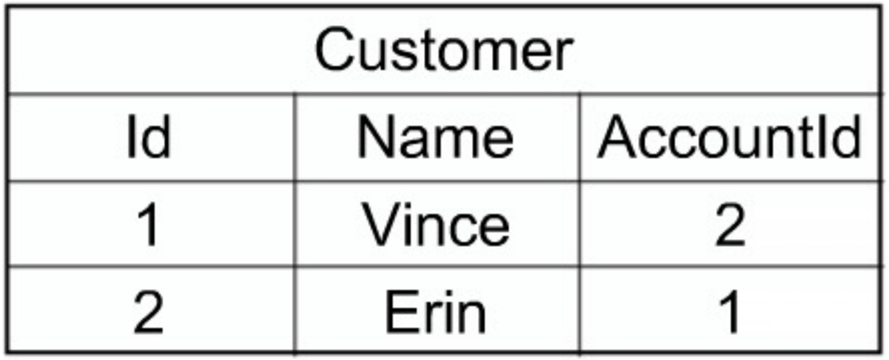
Stud_id	Last_name	Group_name
...	...	...

table.column format

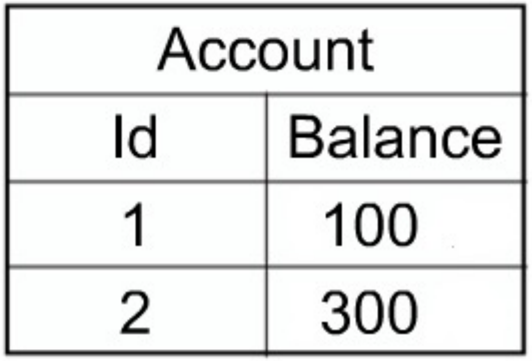
- The table.column format used in the above selection condition.
- This syntax is used to resolve naming conflicts if fields in the tables have the same name.
- This syntax may be used in the SELECT clause or WHERE clause.

Join: example 2

```
CREATE TABLE Account (
    id int PRIMARY KEY,
    balance int);
CREATE TABLE Customer (
    id int PRIMARY KEY,
    name varchar (20),
    accountid int REFERENCES Account (id));
```



Customer		
Id	Name	AccountId
1	Vince	2
2	Erin	1

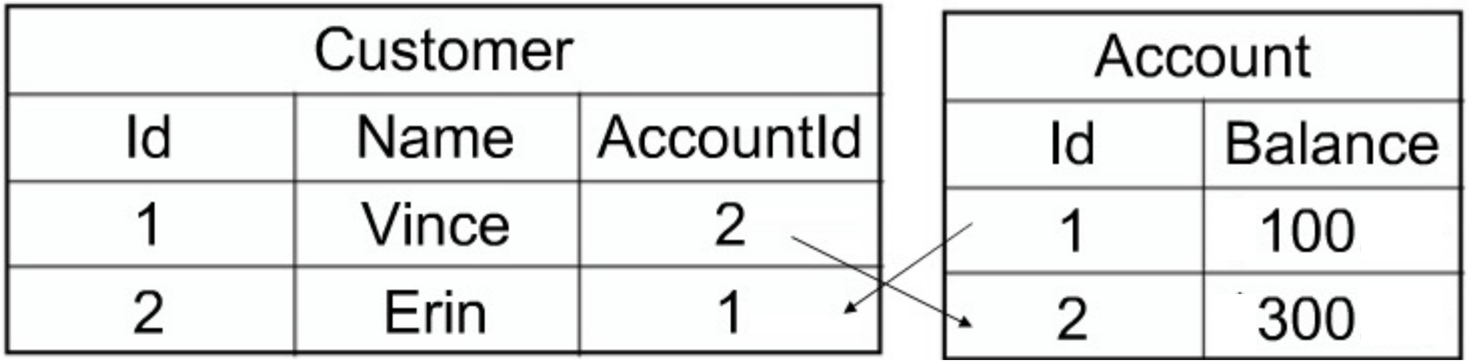


Account	
Id	Balance
1	100
2	300

Join: example 2

- Suppose we want to query the name of the Customer who has Balance = 100.

- We can do this by joining the Account and Customer tables where they are equal – where the FK of Customer (AccountId) is equal to the PK of the Account (Id).



Customer		
Id	Name	AccountId
1	Vince	2
2	Erin	1

Account	
Id	Balance
1	100
2	300

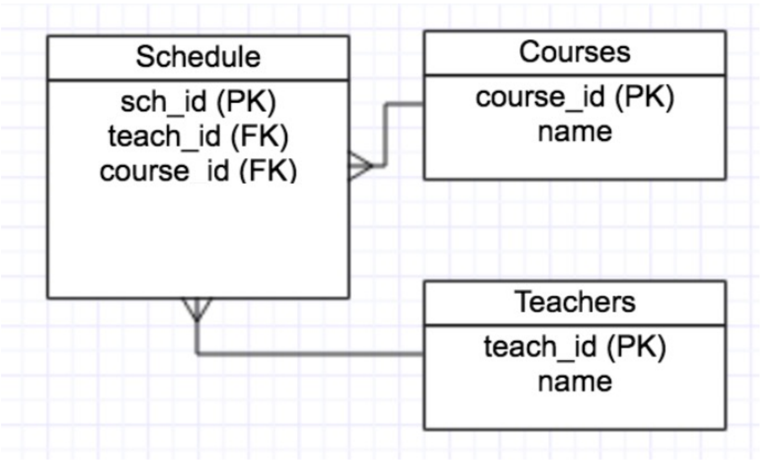
Join: example 2

- SQL query with 2 conditions:

```
SELECT name
FROM Customer, Account
WHERE Customer.accountid = Account.id
AND Account.balance = 100;
```

Join: example 3

```
CREATE TABLE Courses (
    course_id int PRIMARY KEY,
    name varchar(30));
CREATE TABLE Teachers (
    teach_id int PRIMARY KEY,
    name varchar (30));
 CREATE TABLE Schedule (
    sch_id int PRIMARY KEY,
    course_id int REFERENCES Courses (course_id),
    teach_id int REFERENCES Teachers (teach_id));
```



Schedule
sch_id (PK)
teach_id (FK)
course_id (FK)

Courses
course_id (PK)
name

Teachers
teach_id (PK)
name

Join: example 3

```
SELECT Courses.name, Teachers.name
FROM Courses, Teachers, Schedule
WHERE Courses.course_id =
Schedule.course_id AND Teachers.teach_id =
Schedule.teach_id;
```

Course_name	Teach_name
…	…

JOIN keyword

SQL JOIN clause is used to combine rows from two or more tables.

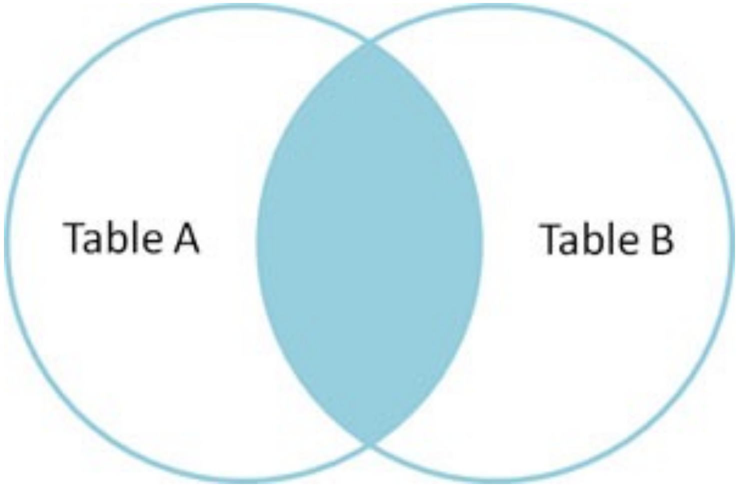
Types:

- INNER JOIN
- OUTER JOIN
    - LEFT JOIN
    - RIGHT JOIN
    - FULL JOIN
- CROSS JOIN

INNER JOIN

The most common type of join is INNER JOIN (simple join).

INNER JOIN returns all rows from multiple tables where the join condition is met.



Syntax:

```
SELECT column_name(s)
FROM tableA
INNER JOIN tableB
ON tableA.column_name = tableB.column_name;
```

INNER JOIN is the same as JOIN.

INNER JOIN: example

```
SELECT stud_id, fname, group_name
FROM Students
INNER JOIN Groups
ON Students.group_id = Groups.group_id;
```

The following example is equivalent:

```
SELECT stud_id, fname, group_name
FROM Students, Groups
WHERE Students.group_id = Groups.group_id;
```

INNER JOIN: example

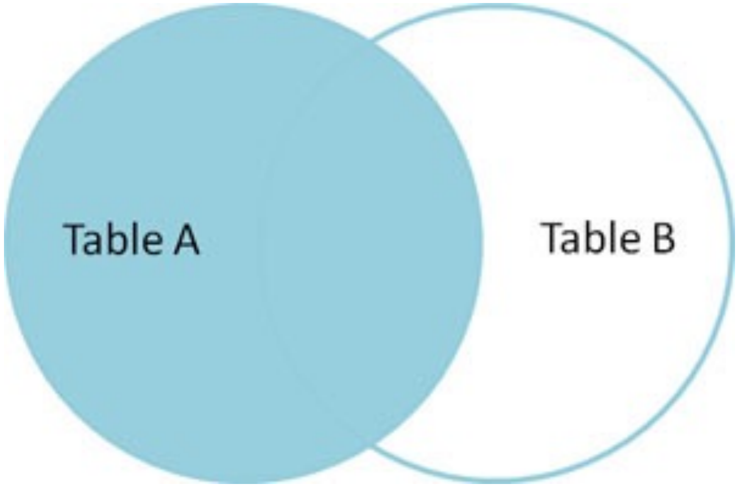
Students		
stud_id	**fname**	**group_id**
1	student1	2
2	student2	2
3	student3	

Groups	
group_id	**group_name**
1	CSSE-1
2	CSSE-2

Result table for INNER JOIN		
stud_id	**fname**	**group_name**
1	student1	CSSE-2
2	student2	CSSE-2

LEFT JOIN

LEFT JOIN keyword returns all rows from the left table (tableA), with the matching rows in the right table (tableB). The result is NULL in the right side when there is no match.



Syntax:

```
SELECT column_name(s)
FROM tableA
LEFT JOIN tableB
ON tableA.column_name = tableB.column_name;
```

In some databases LEFT JOIN is used only like LEFT OUTER JOIN.

LEFT JOIN: example

The following SQL statement will return all students, and groups they might have:

```
SELECT stud_id, fname, group_name
FROM Students
LEFT JOIN Groups
ON Students.group_id = Groups.group_id;
```

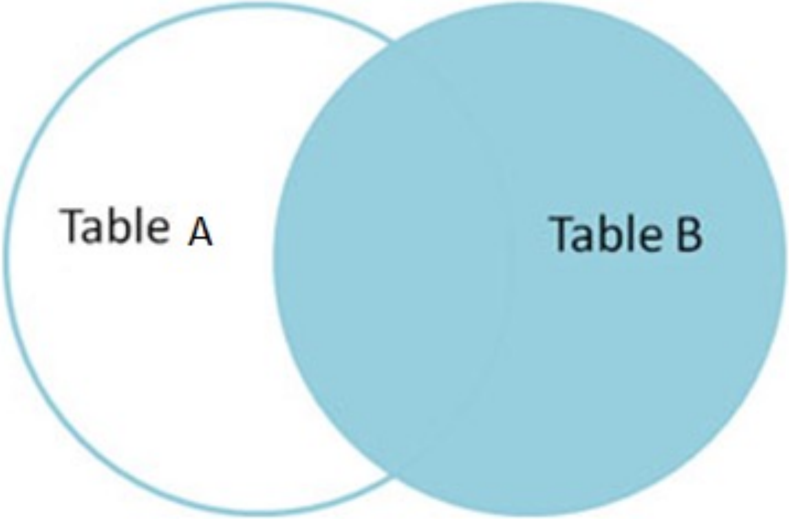
LEFT JOIN
returns all the rows from the left table (Students), even if there are no matches in the right table (Groups):

Result table for LEFT JOIN

stud_id	fname	group_name
1	student1	CSSE-2
2	student2	CSSE-2
3	student3	

RIGHT JOIN

RIGHT JOIN keyword returns all rows from the right table (tableB), with the matching rows in the left table (tableA). The result is NULL in the left side when there is no match.



Syntax:

```
SELECT column_name(s)
FROM tableA
RIGHT JOIN tableB
ON tableA.column_name=tableB.column_name;
```

In some databases RIGHT JOIN is used only like RIGHT OUTER JOIN.

RIGHT JOIN: example

The following SQL statement will return all groups, and students they might have:

```
SELECT stud_id, fname, group_name
FROM Students
RIGHT JOIN Groups
ON Students.group_id = Groups.group_id;
```

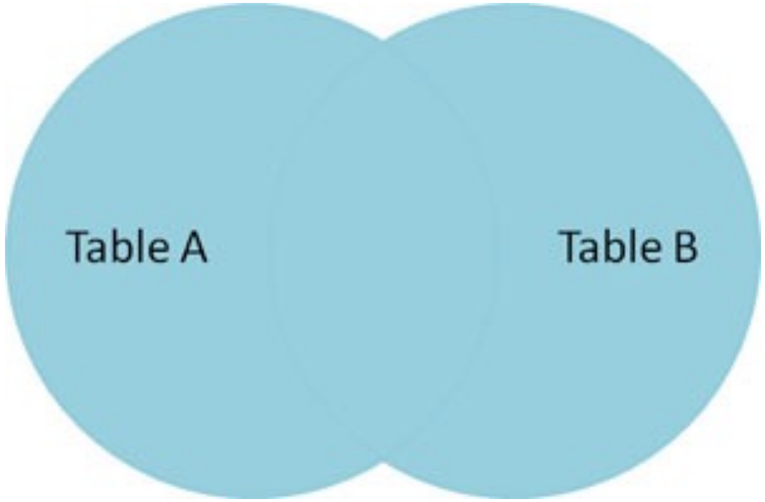
RIGHT JOIN keyword returns all the rows from the right table (Groups), even if there are no matches in the left table (Students):

Result table for RIGHT JOIN		
stud_id	**fname**	**group_name**
1	student1	CSSE-2
2	student2	CSSE-2
		CSSE-1

FULL OUTER JOIN

FULL OUTER JOIN keyword returns all rows from the left table (tableA) and from the right table (tableB).

The FULL OUTER JOIN keyword combines the result of both LEFT and RIGHT joins.



Syntax:

```
SELECT column_name(s)
FROM tableA
FULL OUTER JOIN tableB
ON tableA.column_name=tableB.column_name;
```

FULL JOIN: example

The following SQL statement selects all students and all groups:

```
SELECT stud_id, fname, group_name
FROM Students
FULL OUTER JOIN Groups
ON Students.group_id = Groups.group_id;
```

FULL OUTER JOIN keyword returns all the rows from the left table (Students) and all the rows from the right table (Groups).

If there are rows in "Students" that do not have matches in “Groups", or if there are rows in “Groups" that do not have matches in “Students", those rows will be listed as well:

Result table for FULL JOIN		
stud_id	**fname**	**group_name**
1	student1	CSSE-2
2	student2	CSSE-2
3	student3	
		CSSE-1

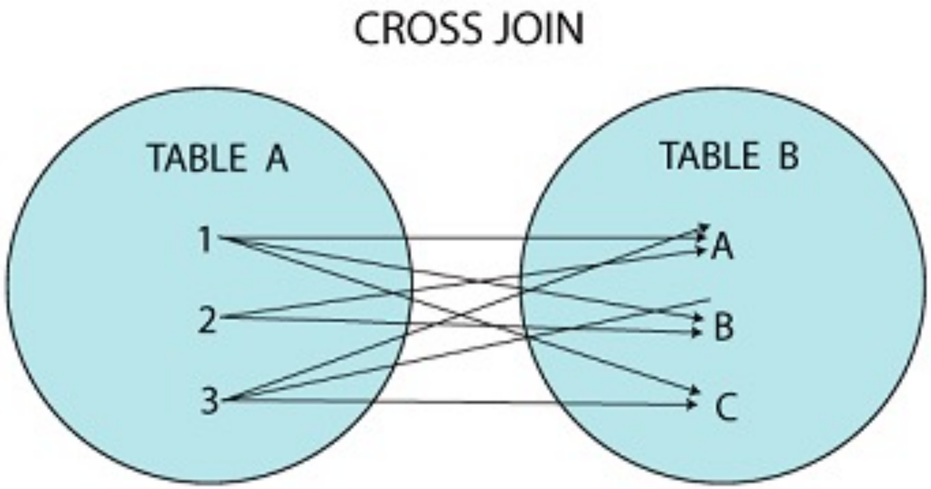
CROSS JOIN

CROSS JOIN produces a result set which is the number of rows in the first table multiplied by the number of rows in the second table (“all-to-all”). WHERE clause is not used along with CROSS JOIN. This kind of result is called as **Cartesian Product**.

```
SELECT *
FROM  tableA
CROSS JOIN tableB;
```

or

```
SELECT *
FROM tableA, tableB
```



CROSS JOIN: example

```
SELECT *
FROM  Students
CROSS JOIN Groups;
```

or

```
SELECT *
FROM Students, Groups;
```

CROSS JOIN: example

Result table for CROSS JOIN				
stud_id	**fname**	**group_id**	**group_id**	**group_name**
1	student1	2	1	CSSE-1
2	student2	2	1	CSSE-1
3	student3		1	CSSE-1
1	student1	2	2	CSSE-2
2	student2	2	2	CSSE-2
3	student3		2	CSSE-2

Going back to join example 1

```
SELECT stud_id, last_name,
                               group_name
FROM Students, Groups
WHERE Students.group_id =
                         Groups.group_id;
```

CROSS JOIN (Cartesian Product) +
selection condition (Selection)

Complete JOIN syntax

```
SELECT Attribute(s)
FROM TableA
{INNER | {LEFT | RIGHT | FULL}
  OUTER | CROSS } JOIN TableB
ON <condition>
```

JOIN with USING

USING clause is a shorthand that allows to take advantage of the specific situation where both sides of the join use the same name for the joining column(s).

It takes a comma-separated list of the shared column names and forms a join condition that includes an equality comparison for each one.

```
SELECT Attribute(s)
FROM TableA
{INNER | {LEFT | RIGHT | FULL} OUTER }
JOIN TableB
USING (join column list);
```

JOIN with USING: example

```
SELECT *
FROM Students
INNER JOIN Groups
USING (group_id);
```

The output of JOIN USING suppresses redundant columns: there is no need to print both of the matched columns, since they must have equal values.

NATURAL JOIN

NATURAL is a shorthand form of USING: it forms a USING list consisting of all column names that appear in both input tables. As with USING, these columns appear only once in the output table.

```
SELECT Attribute(s)
FROM TableA
NATURAL {INNER | {LEFT | RIGHT | FULL} OUTER } JOIN TableB;
```

NATURAL JOIN: example

```
SELECT *
FROM Students
NATURAL INNER JOIN Groups;
```

Notation

Operations have their own symbols.

Operation	Symbol
Projection	π
Selection	σ
Union	$\cup$
Intersection	$\cap$
Set difference	-
Cartesian product	$\times$
Join	$\bowtie$
Left outer join	⟕
Right outer join	⟖
Full outer join	⟗

Books

- Connolly, Thomas M. Database Systems: A Practical Approach to Design, Implementation, and Management / Thomas M. Connolly, Carolyn E. Begg.- United States of America: Pearson Education

- Garcia-Molina, H. Database system: The Complete Book / Hector Garcia-Molina.- United States of America: Pearson Prentice Hall

- Sharma, N. Database Fundamentals: A book for the community by the community / Neeraj Sharma, Liviu Perniu.- Canada

- www.postgresql.org/docs/manuals/