

SQL: Structured Query Language SELECT Statement

SELECT Statement

The core of SQL, is the SELECT statement. Basic SELECT statement looks as follows:

```
SELECT [ DISTINCT ] select-list
FROM from-list
[ WHERE qualification ]
```

More complex SELECT statements will be studied later.

- *from-list* contains the list of database relations from which the data is to be retrieved.
- *select-list* contains the list of relation attributes (possibly modified) to be returned in the answer to the query.
- *qualification* contains the conditions which must be satisfied by a database record to be put into the answer set.

Evaluation of SELECT statement:

1. *from-list* defines a *cartesian product* of all relations in it.
2. *qualification* defines *selection* and *join* conditions on the data.
3. *select-list* defines the final look of the output, i.e., the *projection* attributes.
4. DISTINCT specifies duplicate elimination in the final answer set (default for SELECT QUERY: no duplicate elimination).

SQL SELECT Statement and Relational Algebra

As one can guess from its evaluation, SELECT statement implements Relational Algebra operations *selection*, *projection*, *cartesian product* and *join*.

SELECT and selection

Relational algebra operation: $\sigma_C(R)$
SELECT statement

```
SELECT *
FROM R
WHERE C;
```

Note: "*" is a special notation for the selection list that includes *all available attributes*.

Example: RA: $\sigma_{salary > 20000}(Employee)$

SQL:

```
SELECT *  
FROM Employee  
WHERE salary > 20000;
```

SELECT and projection

Relational algebra operation: $\pi_F(R)$
SELECT statement

```
SELECT DISTINCT F  
FROM R;
```

Note: Relational algebra operations return sets (with no duplicates), hence to represent *true* relational algebra projection, we need to use DISTINCT here. While we may ignore this sometimes, please, keep this fact in mind.

Example: RA: $\pi_{name,salary,position}(Employee)$
SQL:

```
SELECT DISTINCT name, salary, position  
FROM Employee;
```

select and Cartesian Product

Relational algebra operation: $R1 \times R2$
SELECT statement

```
SELECT *  
FROM R1, R2;
```

Note: As mentioned above, more than one relation in the from list represents Cartesian Product.

Example: RA: $Employee \times Client$
SQL:

```
SELECT *  
FROM Employee, Client;
```

select and Cartesian Product

Relational algebra operation: $R1 \bowtie_{R1.A=R2.B} R2$
SELECT statement

```
SELECT *  
FROM R1, R2  
WHERE R1.A = R2.B
```

Note: For clarity, a simple equijoin is used here. This conversion can be extended to other types of join.

Example: RA: $Employee \bowtie_{Employee.manages=Client.id} Client$
SQL:

```
SELECT *  
FROM Employee, Client  
WHERE Employee.manages = Client.id
```

From-list

from-list of the SELECT statement has the following format:

TableName [*TableAlias*] [...]

- *TableName* is a name of the existing database relation.
- *TableAlias* also known as *range variable* is an identifier that can be used *instead of TableAlias*.

While there can be two *TableNames* that have the same value in a from-list, all *TableAliases* are unique! Table aliases allow representation of self-joins in SQL.

Example

Find all employees in John Smith's department who have a bigger salary than John and output their records side by side.

```
SELECT *
FROM Employee E1, Employee E2
WHERE E1.department = E2.department
      AND E1.salary < E2.salary
      AND E1.name = 'John_Smith';
```

Select-list

A simple select-list is a comma-separated sequence of attribute names. However, more complex expressions can appear in a select list.

- *: as mentioned above, this is a shortcut for “all attributes of all relations involved in the query in their natural order”. If a '*' is used, no other attributes may be in the select-list.
- *AttributeName*: a simple attribute name can be part of a select-list if the attribute name alone is sufficient to uniquely identify the attribute among all attributes involved in the query.
- *TableName.AttributeName*: if two different relations involved in the query have attributes with the same name, table name must preface the attribute name to guarantee unambiguous identification.
- *TableAlias.AttributeName*: whenever table alias is defined for a relation *it is always safe* to reference the attribute in this manner. This is also the only way to indicate the exact attribute to be included into select-list in self-joins.
- *Expression*: An expression over different attributes involved in a query is can also be returned in select-list.
- *AttributeSpec AS NewAttributeName*: this form is used to rename the attribute in the result of the query. It can be used to give names to the attributes that are results of expressions as well as to replace *TableName.AttributeName* names with simpler attribute names.
- *Aggregate Expressions*: SELECT queries also allow for return of aggregate expressions (sums, averages, minimums and maximums, etc.) of attributes. More on that later.

Set Operations in SQL

SELECT statement incorporates a combination of *selection*, *projection*, and *cartesian product* operations (which also enables *join*). It does not, by itself, allow is to express set operations in relational algebra. The latter is done using three special SQL statements.

Union in SQL

The format of the union statement is:

```
Expression UNION Expression
```

Here, *Expression* is any expression that resolves as a relational table. Typically, it will be a SELECT statement.

The result of the statement is a relational table which is a union of the two table represented by the right-hand side and left-hand side expressions. Duplicates are automatically eliminated.

For example, if A and B are two relations with the same schema, to compute their union, we use the following query:

```
SELECT * FROM A
UNION
SELECT * FROM B
```

Difference in SQL

MySQL does not support a single difference operator.¹

To replicate set difference, a semi-join can be used. (We will discuss SQL joins in detail later). For example, to compute the difference between two tables A and B with the same schema, write the following query:

```
SELECT *
FROM A LEFT JOIN B USING(someColumn)
WHERE B.someColumn IS NULL;
```

Intersection in SQL

List difference, MySQL does not support a single intersection operator.²

To replicate set intersection, a simple natural join can be used. For example, to compute the intersection between two tables A and B with the same schema, write the following query:

```
SELECT *
FROM A NATURAL JOIN B;
```

Examples

1. Different attribute identifiers. *Find all books that were borrowed at least twice in 2002 and output the names of the two borrowers in each record in chronological order.*

```
SELECT title , Book.id , P1.name , P2.name
FROM Books , Loans L1 , Loans L2 , Patrons P1 , Patrons P2
WHERE Books.id = L1.bId AND Books.id = L2.bId
AND P1.id = L1.pId AND P2.id = L2.pId
AND L1.date < L2.date AND L1.date > DATE( '2001-12-31 ' );
```

Note: This query is a 5-way join that includes two self-joins: on *Patrons* and *Loans*. *title* attribute is unambiguous as it exists only in *Books*. Book qualifier is needed for *Book.id* because *Patrons* relation also has *id* field. Finally, *P1* and *P2* qualifiers for the two *name* attributes are needed to indicate which attribute comes from which copy of the *Patrons* relation.

¹Some other SQL servers such as Oracle SQL and PostgreSQL do support a difference operator usually called EXCEPT or MINUS.

²Some other SQL servers such as Oracle SQL and PostgreSQL do support a difference operator usually called INTERSECT.

2. Expressions as columns. *Output for each employee the sum of his/her salary and bonus.*

```
SELECT name, salary + bonus  
FROM Employee;
```

3. Renaming output columns *Output for each employee the sum of his/her salary and bonus.*

```
SELECT name AS Employee_Name, salary + bonus as Compensation  
FROM Employee;
```

Note: same query as above, only the first field is renamed "Employee_Name" and the second field is given a new name "Compensation".