SQL Queries

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The SELECT-FROM-WHERE Structure

```
SELECT <attributes>
FROM <tables>
WHERE <conditions>
```

From relational algebra:

- `SELECT <attributes>` corresponds to projection
- `FROM <tables>` specifies the table in parentheses in a relational algebra expression and joins
- `WHERE <conditions>` corresponds to selection

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Projection

$\pi_{first\_name,last\_name}(author)$

```
mysql> select first_name, last_name from author;
+------------+-----------+
| first_name | last_name |
+------------+-----------+
| John       | McCarthy  |
| Dennis     | Ritchie   |
| Ken        | Thompson  |
| Claude     | Shannon   |
| Alan       | Turing    |
| Alonzo     | Church    |
| Perry      | White     |
| Moshe      | Vardi     |
| Roy        | Batty     |
+------------+-----------+
9 rows in set (0.00 sec)
```

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Asterisk

```
mysql> select * from author;
+-----------+------------+-----------+
| author_id | first_name | last_name |
+-----------+------------+-----------+
|         1 | John       | McCarthy  |
|         2 | Dennis     | Ritchie   |
|         3 | Ken        | Thompson  |
|         4 | Claude     | Shannon   |
|         5 | Alan       | Turing    |
|         6 | Alonzo     | Church    |
|         7 | Perry      | White     |
|         8 | Moshe      | Vardi     |
|         9 | Roy        | Batty     |
+-----------+------------+-----------+
9 rows in set (0.00 sec)
```

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Notice that with no condition on select, all rows returned.

Select

$\sigma_{year=2012}(book)$

```
mysql> select * from book where year = 2012;
+---------+------------+-------+------+--------+
| book_id | book_title | month | year | editor |
+---------+------------+-------+------+--------+
|       7 | AAAI       | July  | 2012 |      9 |
|       8 | NIPS       | July  | 2012 |      9 |
+---------+------------+-------+------+--------+
2 rows in set (0.00 sec)
```

The FROM Clause

The `FROM` clause takes one or more source tables from the database and combines them into one (large) table using the `JOIN` operator. Three kinds of joins:

- CROSS JOIN
- INNER JOIN
- OUTER JOIN

Sicne DB designs are typically factored into many tables, the join is the most important part of a query.

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CROSS JOIN

A CROSS JOIN matches every row of the first table with every row of the second table. Think of a cross join as a cartesian product.

The general syntax for a cross join is:

```
SELECT <select_header> FROM <table1> CROSS JOIN
    <table2>
```

or

```
SELECT <select_header> FROM <table1>, <table2>
```

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CROSS JOIN EXAMPLE

```
mysql> select * from pub cross join book;
+--------+-----------------+---------+---------+-------
| Pub_id | title           | book_id | book_id |
   book_title | month | year | editor |
+--------+-----------------+---------+---------+-------
|      1 | LISP            |       1 |       1 | CACM
         | April   | 1960 |      8 |
|      2 | Unix            |       2 |       1 | CACM
         | April   | 1960 |      8 |
|      3 | Info Theory     |       3 |       1 | CACM
         | April   | 1960 |      8 |
|      4 | Turing Machines |       4 |       1 | CACM
         | April   | 1960 |      8 |
|      5 | Turing Test     |       5 |       1 | CACM
         | April   | 1960 |      8 |
|      6 | Lambda Calculus |       6 |       1 | CACM
         | April   | 1960 |      8 |
```

~LIMIT~ing Results

If we don't want many results to scroll past the bottom of the screen we can limit the number of results using a LIMIT clause.

```
mysql> select * from pub, book limit 3;
+--------+------------+---------+---------+-----------
| pub_id | title      | book_id | book_id |
   book_title | month | year | editor |
+--------+------------+---------+---------+-----------
|      1 | LISP       |       1 |       1 | CACM
         | April | 1960 |    8 |
|      2 | Unix       |       2 |       1 | CACM
         | April | 1960 |    8 |
|      3 | Info Theory |      3 |       1 | CACM
         | April | 1960 |    8 |
+--------+------------+---------+---------+-----------
3 rows in set (0.00 sec)
```

The general form of the LIMIT clause is LIMIT start, count,

Inner Joins

A simple inner join uses an `ON` condition.

```
mysql> select * from pub join book on
    pub.book_id = book.book_id;
+--------+-----------------+---------+---------+-------
| pub_id | title           | book_id | book_id |
    book_title | month | year | editor |
+--------+-----------------+---------+---------+-------
|      1 | LISP            |       1 |       1 | CACM
         | April    | 1960 |     8 |
|      2 | Unix            |       2 |       2 | CACM
         | July     | 1974 |     8 |
|      3 | Info Theory     |       3 |       3 | BST
         | July     | 1948 |     2 |
|      4 | Turing Machines |       4 |       4 | LMS
         | November | 1936 |     7 |
|      5 | Turing Test     |       5 |       5 | Mind
         | October  | 1950 |  NULL |
```

Natural Joins

The USING clause, also called a natural join, equijoins on a like-named column from each table and includes the join column only once.

```
mysql> select * from pub join book using
    (book_id);
+---------+--------+-----------------+-----------+----
| book_id | pub_id | title           | book_title |
    month  | year | editor |
+---------+--------+-----------------+-----------+----
|       1 |      1 | LISP            | CACM       |
    April    | 1960 |      8 |
|       2 |      2 | Unix            | CACM       |
    July     | 1974 |      8 |
|       3 |      3 | Info Theory     | BST        |
    July     | 1948 |      2 |
|       4 |      4 | Turing Machines | LMS        |
    November | 1936 |      7 |
```

Many to Many Relationships

A single author can write many publications, and a single publication can have many authors. This is a many-to-many relationship, which is modeled in relational databases with a relationship (or link or bridge) table.

```
CREATE TABLE IF NOT EXISTS author_pub (
  author_id INTEGER NOT NULL REFERENCES
      author(author_id),
  pub_id INTEGER NOT NULL REFERENCES
      publication(pub_id),
  author_position INTEGER NOT NULL, -- first
      author, second, etc?
  PRIMARY KEY (author_id, pub_id)
);
```

author_pub tables links the author and pub tables

- author_id and pub_id are foreign keys to author and pub tables

Joining Multiple Tables

We can join all three tables by chaining join clauses:

```
mysql> select *
    -> from author join author_pub using
       (author_id)
    ->   join pub using (pub_id);
+--------+-----------+------------+-----------+---------
| pub_id | author_id | first_name | last_name |
   author_position | title   | book_id |
+--------+-----------+------------+-----------+---------
|      1 |         1 | John       | McCarthy  |
                1 | LISP          |       1 |
|      2 |         2 | Dennis     | Ritchie   |
                1 | Unix          |       2 |
|      2 |         3 | Ken        | Thompson  |
                2 | Unix          |       2 |
|      3 |         4 | Claude     | Shannon   |
                1 | Info Theory   |       3 |
```

String Matching with LIKE

Our where condition can match a pattern with like. Use a % for wildcard, i.e., matching any character sequence.
Which publications have "Turing" in their titles?

```
elect * from pub where title like 'Turing%';
+--------+-------------------+---------+
| pub_id | title             | book_id |
+--------+-------------------+---------+
|      4 | Turing Machines   |       4 |
|      5 | Turing Test       |       5 |
+--------+-------------------+---------+
2 rows in set (0.00 sec)
```

Note that strings are not case-sensitive.

Simple Database: Dorms

1. Download [dorms.sql](../resources/dorms.sql)
2. On the command line, go to the directory where you downloaded dorms.sql
3. Make sure your MySQL server is running:

```
$ mysql.server start
Starting MySQL
SUCCESS!
```

4. Run the `dorms.sql` script like this:

```
$ mysql -u root -p < dorms.sql
Enter password:
```

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Running Queries on the Dorms Database

Start MySQL's client and use the dorms database.

```
$ mysql -u root -p
Enter password:
Welcome to the MySQL monitor. Commands end with
    ; or \g.
...
mysql> use dorms
...
Database changed
mysql>
```

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Exploring the Database

Get a list of the tables:

```
mysql> show tables;
+-----------------+
| Tables_in_dorms |
+-----------------+
| dorm            |
| student         |
+-----------------+
2 rows in set (0.00 sec)
```

See the structure of a table:

```
mysql> describe dorm;
+---------+---------+------+-----+---------+-------+
| Field   | Type    | Null | Key | Default | Extra |
+---------+---------+------+-----+---------+-------+
| dorm_id | int(11) | NO   | PRI | NULL    |       |
```

Simple Queries on Dorms Database

- What are the names of all the dorms?
- Which students have GPAs greater than 3.0?
- Which students are in Armstrong?
- Rank students by GPA.
- Which student has the top GPA?

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