MySQL Tutorial

How to Install MySQL 5.7 (on Windows, Mac OS X, Ubuntu) and Get Started with SQL Programming

This article is applicable to MySQL 5.7. There are some non-compatible changes in MySQL 5.7.7 over 5.6 (read "How to Install MySQL 5.6" for installing MySQL 5.6).

This practical can be completed in a 2-3 hour session, if you don't encounter major problems installing MySQL.

1. Introduction to Relational Database and SQL

1.1 Relational Databases

A *relational database* organizes data in *tables*. A *table* has *rows* (or *records*) and *columns* (or *fields*). Tables are *related* based on common columns to eliminate *data redundancy* and ensure *data integrity*.

Popular Relationship Database Management System (RDBMS) includes the commercial Oracle, IBM DB2, Microsoft SQL Server and Access, SAP SyBase and Teradata; and the open-source MySQL, PostgreSQL, Embedded Apache Derby (Java DB), mSQL (mini-SQL), SQLite and Apache OpenOffice's Base.

1.2 Structure Query Language (SQL)

A high-level language, called *Structure Query Language* (SQL), is designed for interacting with the relational databases. SQL defines a set of commands, such as `SELECT`, `INSERT`, `UPDATE`, `DELETE`, `CREATE TABLE`, `DROP TABLE`, and etc.

Edgar F. Codd (of IBM) proposed the Relational Database Model in 1970. SQL, one of the earlier programming language, was subsequently developed by Donald D. Chamberlin and Raymond F. Boyce at IBM in the early 1970s. Oracle, subsequently, took it to a new height.

ANSI (American National Standard Institute) established the first SQL standard in 1986 (SQL-86 or SQL-87) - adopted by ISO/IEC as "ISO/IEC 9075" - followed in 1989 (SQL-89), 1992 (SQL-92 or SQL2), 1999 (SQL-99 or SQL3), 2003 (SQL-2003), 2006 (SQL-2006) and 2011 (SQL-2011). However, most of the database vendors have their own directs, e.g., PL/SQL (Oracle), Transact-SQL (Microsoft, SAP), PL/pgSQL (PostgreSQL).

1.3 SQL By Examples

A relational database system contains many *databases*. A database comprises one or more *tables*. A table have *rows* (or *records*) and *columns* (or *fields*).

Suppose we have created a table called `class101`, in a database called `studentdb`, with 3 columns: `id`, `name` and `gpa`. A column has a

data type. We choose: `INT` (integer) for column `id`, `FLOAT` (floating-point number) for `gpa`, and `VARCHAR(50)` (variable-length string of up to 50 characters) for `name`. There are 4 rows in the table as follows:

```
Database: studentdb
Table: class101
+-----------+--------------------+-------------+
| id (INT)  | name (VARCHAR(50)) | gpa (FLOAT) |
+-----------+--------------------+-------------+
|   1001    | Tan Ah Teck        |  4.5        |
|   1002    | Mohammed Ali       |  4.8        |
|   1003    | Kumar              |  4.8        |
|   1004    | Kevin Jones        |  4.6        |
+-----------+--------------------+-------------+
```

SQL provides an easy and intuitive way to interact with relational databases.

SELECT

```
-- SYNTAX
SELECT column1, column2, ... FROM tableName WHERE criteria
SELECT * FROM tableName WHERE criteria

-- EXAMPLES
SELECT name, gpa FROM class101
   -- Select columns name and gpa from table class101.
   +--------------+------+
   | name         | gpa  |
   +--------------+------+
   | Tan Ah Teck  |  4.5 |
   | Mohammed Ali |  4.8 |
   | Kumar        |  4.8 |
   | Kevin Jones  |  4.6 |
   +--------------+------+

SELECT * FROM class101
   -- Select ALL columns from table class101.
   -- The wildcard * denotes all the columns.
   +------+--------------+------+
   | id   | name         | gpa  |
   +------+--------------+------+
   | 1001 | Tan Ah Teck  |  4.5 |
   | 1002 | Mohammed Ali |  4.8 |
   | 1003 | Kumar        |  4.8 |
   | 1004 | Kevin Jones  |  4.6 |
   +------+--------------+------+

SELECT name, gpa FROM class101 WHERE gpa >= 4.7
   -- Select columns name and gpa, where the rows meet the criteria.
   -- You can compare numbers using =, >, <, >=, <=, <> (!=)
   +--------------+------+
   | name         | gpa  |
   +--------------+------+
   | Mohammed Ali |  4.8 |
   | Kumar        |  4.8 |
   +--------------+------+

SELECT name, gpa FROM class101 WHERE name = 'Tan Ah Teck'
   -- Full-match (= or !=) on string. Strings are enclosed in quotes.
   +-------------+------+
   | name        | gpa  |
   +-------------+------+
   | Tan Ah Teck |  4.5 |
   +-------------+------+

SELECT name FROM class101 WHERE name LIKE 'k%'
   -- Use "LIKE" for string pattern-matching, with
   --   wildcard % matches zero or more (any) characters;
   --   wildcard _ matches one (any) character.
   +-------------+
```

```
   | name        |
   +-------------+
   | Kumar       |
   | Kevin Jones |
   +-------------+

SELECT * FROM class101 WHERE gpa > 4 AND name LIKE 'k%' ORDER BY gpa DESC, name ASC
   -- Use AND, OR, NOT to combine simple conditions.
   -- Order the results in DESC (descending) or ASC (Ascending)
   +------+-------------+------+
   | id   | name        | gpa  |
   +------+-------------+------+
   | 1003 | Kumar       |  4.8 |
   | 1004 | Kevin Jones |  4.6 |
   +------+-------------+------+
```

DELETE

```
-- SYNTAX
DELETE FROM tableName WHERE criteria

-- EXAMPLES
DELETE FROM class101
  -- Delete ALL rows from the table class101! Beware that there is NO UNDO!
DELETE FROM class101 WHERE id = 33
  -- Delete rows that meet the criteria.
```

INSERT

```
-- SYNTAX
INSERT INTO tableName VALUES (firstColumnValue, ..., lastColumnValue)       -- All columns
INSERT INTO tableName (column1, column2, ...) VALUES (value1, value2, ...)  -- Selected Columns

-- Example
INSERT INTO class101 VALUES (1001, 'Tan Ah Teck', 4.5)
  -- List value of all columns.
INSERT INTO class101 (name, gpa) VALUES ('Peter Jones', 4.55)
  -- Missing fields will be set to their default values or NULL
```

UPDATE

```
-- SYNTAX
UPDATE tableName SET column = value WHERE criteria

-- EXAMPLES
UPDATE class101 SET gpa = 5.0                                  -- ALL rows
UPDATE class101 SET gpa = gpa + 1.0 WHERE name = 'Tan Ah Teck' -- Selected rows
```

CREATE TABLE

```
-- SYNTAX
CREATE TABLE tableName (column1Name column1Type, column2Name column2Type, ...)

-- EXAMPLES
CREATE TABLE class101 (id INT, name VARCHAR(50), gpa FLOAT)
```

DROP TABLE

```
-- SYNTAX
DROP TABLE tableName

-- EXAMPLES
DROP TABLE class101  -- Delete the table. Beware that there is No UNDO!!!
```

Notes:

1. **Case Sensitivity**: SQL keywords, names (identifiers), strings may or may not be case-sensitive, depending on the implementation.
   - In MySQL, the *keywords* are NOT case-sensitive. For clarity, I show the keywords in UPPERCASE in this article.
   - For programmers, it is BEST to treat the *names (identifiers)* and *strings* as case-sensitive.
     [In MySQL, column-names are always case insensitive; but table-names are case-sensitive in Unix, but case-insensitive in Windows (confused!!). Case-sensitivity in string comparison depends on the *collating sequence* used (?!).]
2. **String**: SQL strings are enclosed in single quotes, but most implementations (such as MySQL) also accept double quotes.

2. Introduction to MySQL Relational Database Management System (RDBMS)

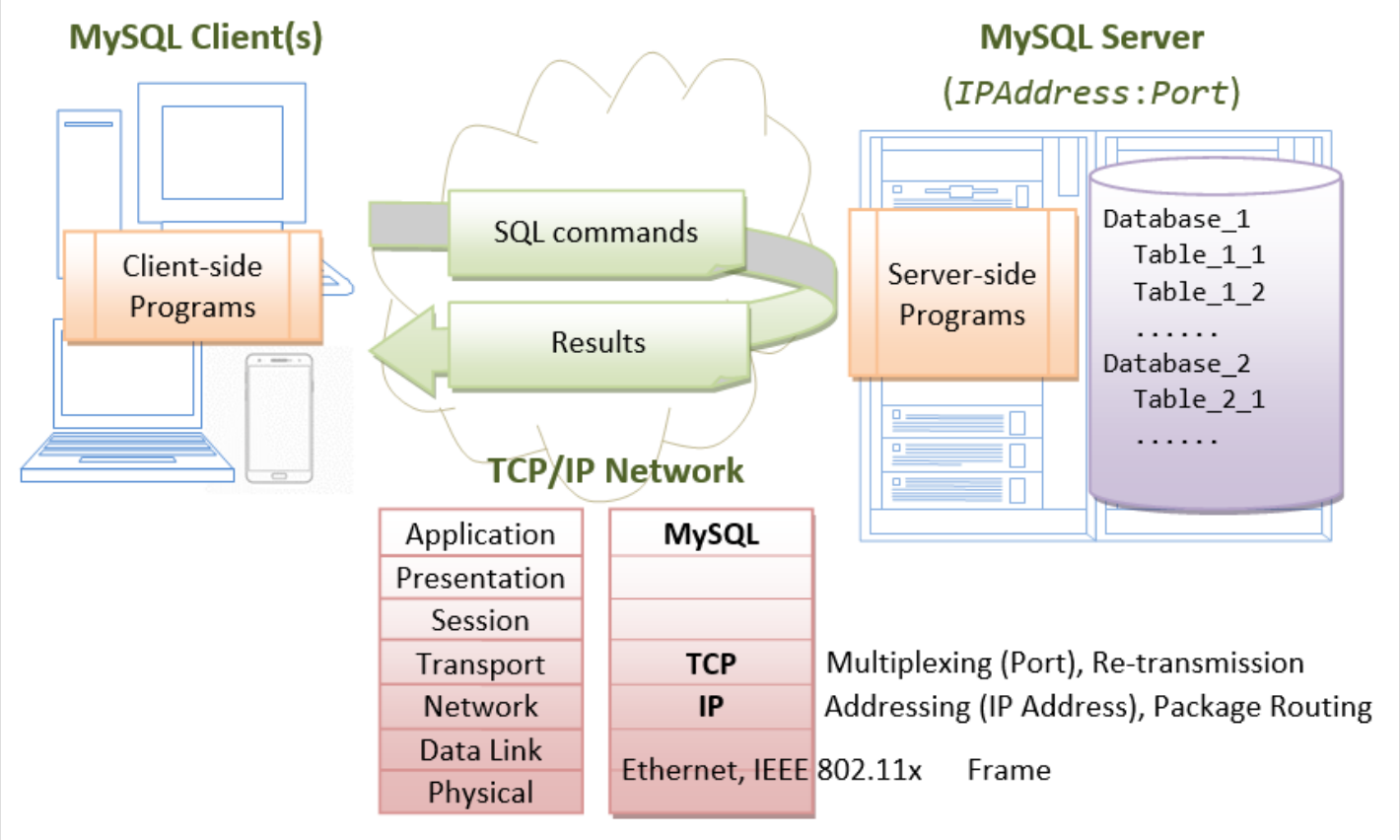
SQL is a *programming language* for interacting with relational databases. On the other hand, MySQL is a *software system* - a Relational Database Management System.

MySQL is one of the most used, *industrial-strength*, *open-source* and *free* Relational Database Management System (RDBMS). MySQL was developed by Michael "Monty" Widenius and David Axmark in 1995. It was owned by a Swedish company called MySQL AB, which was bought over by Sun Microsystems in 2008. Sun Microsystems was acquired by Oracle in 2010.

MySQL is successful, not only because it is free and open-source (there are many free and open-source databases, such as Apache Derby (Java DB), mSQL (mini SQL), SQLite, PostgreSQL and Apache OpenOffice's Base), but also for its speed, ease of use, reliability, performance, connectivity (full networking support), portability (run on most OSes, such as Unix, Windows, Mac), security (SSL support), small size, and rich features. MySQL supports all features expected in a high-performance relational database, such as transactions, foreign key, replication, subqueries, stored procedures, views and triggers.

MySQL is often deployed in a LAMP (Linux-Apache-MySQL-PHP), WAMP (Windows-Apache-MySQL-PHP), or MAMP (MacOS-Apache-MySQL-PHP) environment. All components in LAMP is free and open-source, inclusive of the Operating System.

The mother site for MySQL is https://www.mysql.com. The ultimate reference for MySQL is the "MySQL Reference Manual", available at https://dev.mysql.com/doc. The reference manual is huge - the PDF has over 3700 pages!!!



MySQL operates as a *client-server* system over TCP/IP network. The server runs on a machine with an IP address, on a chosen TCP port number. The default TCP port number for MySQL is 3306. Users can access the server via a client program, connecting to the

server at the given IP address and TCP port number.

A MySQL database server contains one or more *databases*. A database contains one or more *tables*. A table consists of *rows* (or *records*) and *columns* (or *fields*).

3. How to Install MySQL 5.7 and Get Started with SQL Programming

I want you to install MySQL on your own machine, because I want you to learn how to install, customize and operate *complex industrial software system*. Installation could be the hardest part in this exercise.

3.1 Step 0: Create a directory to keep all your works

Create a directory called "`c:\myWebProject`" (for Windows) or "`~/myWebProject`" (for Mac OS X) to keep all your works.

```
// For Windows: Use "C:\myWebProject"
// Launch a "CMD" and issue these commands:
c:
cd \
mkdir myWebProject

// For Mac OS X: Use "~/myWebProject" (where "~" denotes your home directory)
// Launch a "Terminal" and issue these commands:
cd
mkdir myWebProject
```

Use your graphical interface, e.g., File Explorer (Windows), or Finder (Mac OS X) to verify this directory. (Of course you can use your graphical interface to create this directory!)

For novices: It is important to follow this step. Otherwise, you will be out-of-sync with this article and will not be able to find your files later.

3.2 Step 1: Download and Install MySQL

For Windows

1. Download MySQL ZIP ARCHIVE from https://dev.mysql.com/downloads/mysql/:
   a. Choose "General Available (GA) Releases" tab.
   b. Under "MySQL Community Server 5.7.xx" ⇒ In "Select Platform", choose "Microsoft Windows".
   c. Under "Other Downloads", download "Windows (x86, 64-bit), ZIP ARCHIVE (mysql-5.7.xx-winx64.zip)" or "Windows (x86, 32-bit), ZIP ARCHIVE (mysql-5.7.xx-win32.zip)".
   (You can check whether your Windows is 32-bit or 64-bit from "Control Panel" ⇒ System and Security (optional) ⇒ System ⇒ Under "System Type". I doubt that there are still 32-bit Windows around!)
   d. There is NO need to "Login" or "Sign up" - Just click "No thanks, just start my downloads!".
2. UNZIP the downloaded file into your project directory "`C:\myWebProject`". MySQL will be unzipped as "`c:\myWebProject\mysql-5.7.{xx}-winx64`".
   For **EASE OF USE**, we shall shorten and rename the directory to "`c:\myWebProject\mysql`". Take note and remember your MySQL installed directory!!!
3. (NEW since MySQL 5.7.7) Initialize the database: Start a CMD (as administrator) ("Search" button ⇒ Enter "cmd" ⇒ Right-Click ⇒ Run as Administrator) and issue these commands:

```
// Change directory to the MySQL's binary directory
// Suppose that your MySQL is installed in "c:\myWebProject\mysql"
c:
cd \myWebProject\mysql\bin

// Initialize the database. Create a root user with random password. Show the messages on console
mysqld --initialize --console
......
...... [Note] A temporary password is generated for root@localhost: xxxxxxxx
```

During the installation, a superuser called `root` is created with a temporary password, as shown above. **TAKE NOTE of the PASSWORD, COPY and save it somewhere, and TAKE A PICTURE!!!!**

4. If you make a mistake somewhere or forgot your password, DELETE the entire MySQL directory "`C:\myWebProject\mysql`", and REPEAT step 2 and 3.

For Mac OS X

Notes: The current version of MySQL (5.7.21) works with Mac OS 10.12 and 10.13. If you are running 10.11 or below, you need to find an archive version of MySQL @ https://dev.mysql.com/downloads/ ⇒ Archive.

1. Download the MySQL "DMG Archive" from https://dev.mysql.com/downloads/mysql/:
   a. Choose "General Available (GA) Releases" tab.
   b. Under "MySQL Community Server 5.7.xx" ⇒ In "Select Platform", choose the "Mac OS X".
   c. Select the appropriate "DMG Archive" for your specific Mac OS version, IF more than one versions are available. Otherwise, you have no other choices!
      - To check your OS version ⇒ Click the 'Apple' logo ⇒ "About this Mac".
      - To check whether your Mac OS is 32-bit or 64-bit ⇒ Read http://support.apple.com/kb/ht3696. Unless you have a dinosaur-era machine, it should be 64-bit!
   d. There is NO need to "Login" or "Sign up" - Just click "No thanks, just start my download".
2. To install MySQL:
   a. Go to "Downloads" ⇒ Double-click "`.dmg`" file downloaded.
   b. Double-click the "`mysql-5.7.{xx}-osx10.x-xxx.pkg`"
   c. Follow the screen instructions to install MySQL. During the installation, a superuser called `root` is created with a temporary random password. **TAKE NOTE of the PASSWORD, COPY and save it somewhere, and TAKE A PICTURE!!!**. For the latest MySQL, password is sent to the notifications as well.
   d. MySQL will be installed in "`/usr/local/mysql`". Take note of this installed directory!!
   e. Eject the "`.dmg`" file.
3. If you make a mistake somewhere or forgot your password, stop the server (Click "Apple" Icon ⇒ System Preferences ⇒ MySQL ⇒ Stop).
   Goto `/usr/local` (via Finder ⇒ Go ⇒ GoTo Folder ⇒ type `/usr/local`) and remove all the folders beginning with "`mysql...`", e.g., "`mysql-5.7.{xx}...`" and "`mysql`", and Re-run Step 2.

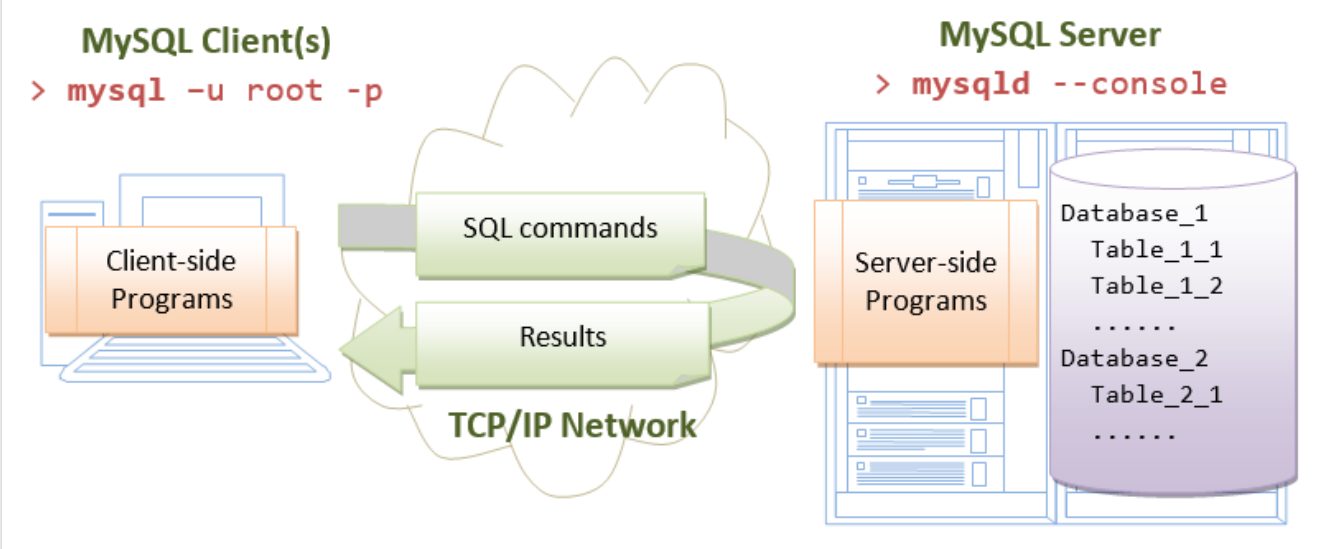
For Ubuntu

Refer to "How to install MySQL 5 on Ubuntu".

I shall assume that MySQL is installed in directory "`c:\myWebProject\mysql`" (for Windows) or "`/usr/local/mysql`" (for Mac OS X). But you need to **TAKE NOTE OF YOUR MySQL INSTALLED DIRECTORY**. Hereafter, I shall denote the MySQL installed directory as `<MYSQL_HOME>` in this article.

3.3 Step 3: Start the "Server"

The MySQL is a *client-server* system. The database is run as a *server* application. Users access the database server via a *client* program, locally or remotely thru the network, as illustrated:



1. The *server* program is called "`mysqld`" (with a suffix `'d'`, which stands for *daemon* - a daemon is a non-interactive process running in the background).
2. The *client* program is called "`mysql`" (without the `'d'`).

The programs `mysqld` and `mysql` are kept in the "`bin`" sub-directory of the MySQL installed directory.

Startup Server

For Windows

To start the database server, launch a new CMD shell:

```
-- Change the current directory to MySQL's binary directory
-- Assume that the MySQL installed directory is "c:\myWebProject\mysql"
c:
cd \myWebProject\mysql\bin

-- Start the MySQL Database Server
mysqld --console
......
......
XXXXXX XX:XX:XX [Note] mysqld: ready for connections.
Version: '5.7.xx'  socket: ''  port: 3306  MySQL Community Server (GPL)
```

Notes: The `--console` option directs the output messages to the console. Without this option, you will see a blank screen.

For Mac OS

The EASY WAY: Via graphical control. Click "Apple" Icon ⇒ System Preferences ⇒ MySQL ⇒ Start or Stop.

The MySQL database server is now started, and ready to handle clients' requests.

Anything that can possibly go wrong, does! Read "Common Problems in Starting the MySQL Server after Installation".

Shutdown Server

For Windows

The quickest way to shut down the database server is to press Ctrl-C to initiate a *normal shutdown*. DO NOT KILL the server via the window's CLOSE button.

Observe these messages from the MySQL server console:

```
XXXXXX XX:XX:XX [Note] mysqld: Normal shutdown
```

```
......
XXXXXX XX:XX:XX  InnoDB: Starting shutdown...
XXXXXX XX:XX:XX  InnoDB: Shutdown completed; log sequence number 0 44233
......
XXXXXX XX:XX:XX [Note] mysqld: Shutdown complete
```

For Mac OS X

The EASY WAY: Via the graphical control. Click "Apple" Icon ⇒ System Preferences ⇒ MySQL ⇒ Stop.

WARNING: You should properly shutdown the MySQL server. Otherwise, you might corrupt the database and might have problems restarting it. BUT, if you encounter problem shutting down the server normally, you may kill the "`mysqld`" process in **Task Manager** (for Windows); or **Activity Monitor** (for Mac OS X); or **System Monitor** (for Ubuntu).

3.4 Step 4: Start a "Client"

Recall that the MySQL is a client-server system. Once the server is started, one or more clients can be connected to the database server. A client could be run on the same machine (local client); or from another machine over the network (remote client).

To login to the MySQL server, you need to provide a *username* and *password*. During the installation, MySQL creates a *superuser* called "`root`" with a temporary password. I hope that you have taken note of this password! (Otherwise, re-install!)

The MySQL installation provides a command-line client program called "`mysql`". (Recall that the server program is called "`mysqld`" with a suffix `'d'`; the client program does not have the suffix 'd').

Let's start a command-line client with the superuser "`root`".

First, make sure that the server is running. See previous step to re-start the server if it has been shutdown.

For Windows

Start **Another NEW** CMD shell to run the client (You need to keep the CMD that run the server):

```
-- Change the current directory to MySQL's binary directory.
-- Assume that the MySQL is installed in "c:\myWebProject\mysql".
c:
cd \myWebProject\mysql\bin

-- Start a client as superuser "root" (-u), and prompt for password (-p)
mysql -u root -p
Enter password:   // Enter the root's password set during installation.
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 1
Server version: 5.7.21
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql>
-- Client started. The prompt changes to "mysql>".
-- You can now issue SQL commands such as SELECT, INSERT and DELETE.
```

For Mac OS

Open a **NEW** "Terminal" and issue these commands to start a MySQL client with superuser `root`:

```
-- Change the current directory to MySQL's binary directory.
cd /usr/local/mysql/bin

-- Start a client with superuser "root" (-u), and prompt for password (-p)
./mysql -u root -p
Enter password:   // Enter the root's password given during installation. You will NOT any * for maximum security
Welcome to the MySQL monitor.  Commands end with ; or \g.
......
mysql>
```

```
-- Client started. The prompt changes to "mysql>".
-- You can now issue SQL commands such as SELECT, INSERT and DELETE.
```

(Skip Unless...) Read "Common Problems in Starting the MySQL Client".

3.5 Step 5: Change the Password for the Superuser "root"

As mentioned earlier, the MySQL installation creates a *superuser* called "`root`" with a temporary random password. "`root`" is a *privileged user* that can do anything, including deleting all the databases. You are required to change the root's password immediately after logging in.

Changing the Password for "root"

Let's continue with our client session started earlier.

```
-- Change password for 'root'@'localhost'. Replace xxxx with your chosen password
-- (For my students: use xxxx as the password. Otherwise, you will ask me what is your password next week.)
-- Take note that strings are to be enclosed by a pair of single-quotes.
mysql> alter user 'root'@'localhost' identified by 'xxxx';
Query OK, 0 rows affected (0.00 sec)

-- logout and terminate the client program
mysql> quit
Bye
```

Re-Start a Client as "root" with the New Password

We have just changed the password for `root` and exited the client. Start a client and login as `root` again. Enter the password when prompted.

For Windows

```
-- Change directory to MySQL's binary directory
c:
cd \myWebProject\mysql\bin
-- Start a MySQL client
mysql -u root -p
Enter password:   // Enter the NEW password
Welcome to the MySQL monitor.
......
mysql>
-- client started, ready to issue SQL command
```

For Mac OS X

```
-- Change directory to MySQL's binary directory
cd /usr/local/mysql/bin
-- Start a MySQL client
./mysql -u root -p
Enter password:  // Enter the NEW password
Welcome to the MySQL monitor.
......
mysql>
-- client started, ready to issue SQL command
```

3.6 Step 6: Create a New User

The superuser "root" is privileged, which is meant for database administration and is not meant for operational. We shall create a new user - let's call it "`myuser`" - with a lesser privilege. To create a new user, start a client with superuser "`root`":

```
-- Start a client, IF IT IS NOT STARTED
```

```
mysql -u root -p     // Windows
./mysql -u root -p   // Mac OS X

-- Create a new user called "myuser", which can login from localhost, with password "xxxx"
mysql> create user 'myuser'@'localhost' identified by 'xxxx';
Query OK (0.01 sec)

-- Grant permission to myuser to perform tasks
mysql> grant all on *.* to 'myuser'@'localhost';
Query OK (0.01 sec)

mysql> quit
```

Explanation

- `CREATE USER 'myuser'@'localhost' IDENTIFIED BY 'xxxx'`
  We use the command "`create user`" to create a new user called `'myuser'@'localhost'`, who can login to the server locally from the same machine (but not remotely from another machine), with password "xxxx".
- `GRANT ALL ON *.* TO 'myuser'@'localhost'`
  The newly created user has NO privilege to perform any database operation including `select`. We use the "`grant`" command to grant "`all`" the privileges (including `select`, `insert`, `delete`, and so on) to this new user on ALL the databases and ALL the tables ("`on *.*`"). This new user, in practice, has the same privilege as `root`, except that it cannot issue `grant` command. For production, you should grant only the necessary privileges on selected databases and selected tables, e.g., "`grant select, insert, update on studentdb.*`" - it can issue `select`, `insert` and `update` (but no `delete`, `create/drop table`) on ALL the tables of the database `studentdb` only.

3.7 Step 7: Create a new Database, a new Table in the Database, Insert Records, Query and Update

A MySQL server contains many *databases*. A database contains many *tables*. A table contains *rows* (*records*) and *columns* (*fields*).

Let's create a database called "`studentdb`", and a table called "`class101`" in the database. The table shall have three columns: `id` (of the type `INT` - integer), `name` (of the type `VARCHAR(50)` - variable-length string of up to 50 characters), `gpa` (of the type `FLOAT` - floating-point number).

CAUTION: Programmers don't use *blank* and *special characters* in *NAMES* (database names, table names, column names). It is either not supported, or will pose you many more challenges.

Tips on Client's Session

Before we proceed, here are some tips on using the client:

- You need to terminate your command with a semicolon (`;`), which sends the command to the server for processing. E.g.,

  ```
  mysql> select * from class101 ;
  -- Terminate a command with ';' to send the command to the server for processing
  ```

- A command can span several lines. The prompt for subsequent lines changes to `->` to denote continuation. You need to terminate the command with a semicolon (`;`). E.g.,

  ```
  mysql> select *
      -> from class101
      ->
      -> ;
  -- A command can span several lines, ended with a semicolon.
  ```

  In other words, if you forget to type `';'` before hitting enter, you can type the `';'` on the next line.

- You can use `\c` to *cancel* (*abort*) the current command. E.g.,

  ```
  mysql> select * from class101 \c
  -- abort (cancel) the command
  ```

- If you open a single quote, without closing it, the continuation prompt changes to `'>` (instead of `->`). For example,

```
mysql> select 'xxx
    '> '\c        // close the single-quote and abort
```

- You can use up/down arrow keys to retrieve the previous/next commands (from the history commands).
- (For Windows) You should enable copy/paste functions of CMD shell. To enable copy/paste, click the CMD's icon ⇒ Properties ⇒ Options ⇒ Edit Options ⇒ Check "QuickEdit Mode". You can then select the desired texts and use a "right-click" to copy the selected text; another "right-click" to paste.

SQL Programming

Let's start a client with our newly-created user "`myuser`".

```
-- Start a client, IF IT IS NOT STARTED
mysql -u myuser -p     // Windows
./mysql -u myuser -p   // Mac OS X

-- Create a new database called 'studentdb'
mysql> create database if not exists studentdb;
Query OK, 1 row affected (0.08 sec)

-- List all the databases in this server
mysql> show databases;
+--------------------+
| Database           |
+--------------------+
| ......             |
| studentdb          |
| ......             |
+--------------------+
x rows in set (0.07 sec)

-- Use 'studentdb' database as the default database
-- You can refer to tables in the default database by the 'tablename' alone, instead of 'databasename.tablename'
mysql> use studentdb;
Database changed

-- Remove the table 'class101' in the default database if it exists
mysql> drop table if exists class101;
Query OK, 0 rows affected, 1 warning (0.15 sec)

-- Create a new table called 'class101' in the default database 'studentdb',
--   with 3 columns of the specified types
mysql> create table class101 (id int, name varchar(50), gpa float);
Query OK, 0 rows affected (0.15 sec)

-- List all the tables in the default database 'studentdb'
mysql> show tables;
+--------------------+
| Tables_in_studentdb |
+--------------------+
| class101           |
+--------------------+
1 row in set (0.00 sec)

-- Describe the 'class101' table (List its columns' definition)
mysql> describe class101;
+-------+-------------+------+-----+---------+-------+
| Field | Type        | Null | Key | Default | Extra |
+-------+-------------+------+-----+---------+-------+
| id    | int(11)     | YES  |     | NULL    |       |
| name  | varchar(50) | YES  |     | NULL    |       |
| gpa   | float       | YES  |     | NULL    |       |
+-------+-------------+------+-----+---------+-------+
3 rows in set (0.04 sec)

-- Insert a row into 'class101' table.
-- Strings are single-quoted. No quotes for INT and FLOAT values.
mysql> insert into class101 values (11, 'Tan Ah Teck', 4.8);
```

```
Query OK, 1 row affected (0.03 sec)

-- Insert another row
mysql> insert into class101 values (22, 'Mohamed Ali', 4.9);
Query OK, 1 row affected (0.03 sec)

-- Select all columns (*) from table 'class101', and all rows
mysql> select * from class101;
+----+-------------+------+
| id | name        | gpa  |
+----+-------------+------+
| 11 | Tan Ah Teck |  4.8 |
| 22 | Mohamed Ali |  4.9 |
+----+-------------+------+
2 rows in set (0.00 sec)

-- Select some columns from table 'class101', and rows that match the conditions
mysql> select name, gpa from class101 where gpa > 4.85;
+-------------+------+
| name        | gpa  |
+-------------+------+
| Mohamed Ali |  4.9 |
+-------------+------+
1 rows in set (0.00 sec)

-- Update the given field of the selected records
mysql> update class101 set gpa = 4.4 where name = 'Tan Ah Teck';
Query OK, 1 row affected (0.05 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> select * from class101;
+----+-------------+------+
| id | name        | gpa  |
+----+-------------+------+
| 11 | Tan Ah Teck |  4.4 |
| 22 | Mohamed Ali |  4.9 |
+----+-------------+------+
2 rows in set (0.00 sec)

-- Delete selected records
mysql> delete from class101 where id = 22;
Query OK, 1 row affected (0.03 sec)

mysql> select * from class101;
+----+-------------+------+
| id | name        | gpa  |
+----+-------------+------+
| 11 | Tan Ah Teck |  4.4 |
+----+-------------+------+
1 rows in set (0.00 sec)

-- You can STORE a set of SQL commands in a FILE (called SQL script) and run the script,
--   instead entering the commands one-by-one.
-- Use a programming text editor to CREATE a NEW FILE called "mycommands.sql"
--   containing the following three SQL statements.
-- (For Windows) Save the file under "c:\myWebProject".
-- (For Mac OS X) Save the file under "~/myWebProject", where "~" denotes home.
insert into class101 values (33, 'Kumar', 4.8);
insert into class101 values (44, 'Kevin', 4.6);
Select * from class101;

-- After you created the file, you can use the following "source" command
--   to run the SQL script.
-- You need to provide the full path to the script.
-- (For Windows) The filename is c:\myWebProject\mycommands.sql.
-- (For Mac OS X) The filename is ~/myWebProject/mycommands.sql
mysql> source c:\myWebProject\mycommands.sql   // For Windows
mysql> source ~/myWebProject/mycommands.sql    // For Mac OS X
Query OK, 1 row affected (0.00 sec)   -- INSERT command output
Query OK, 1 row affected (0.00 sec)   -- INSERT command output
```

```
+------+-------------+------+         -- SELECT command output
| id   | name        | gpa  |
+------+-------------+------+
|   11 | Tan Ah Teck |  4.4 |
|   33 | Kumar       |  4.8 |
|   44 | Kevin       |  4.6 |
+------+-------------+------+
3 rows in set (0.00 sec)
```

Exercises:

1. Select records with names starting with letter `'K'`. (Hints: `name like 'K%'`, see Section "SQL by Examples")
2. Select records with names NOT starting with letter `'K'`. (Hints: `name NOT like ...`)
3. Select records with `gpa` between 4.35 and 4.65. (Hints: `test-1 AND test-2`)
4. Select records with names having a letter `'e'`. (Hints: `name like '%e%'`)
5. Select records with names having a letter `'e'` or `'a'`. (Hints: `test-1 OR test-2`)
6. Select records with names having a letter `'e'` and `gpa ≥ 4.5`.

(Skip Unless...) Read "Common Problems in Using the mysql Client".

3.8 More Exercises

1. Show all the databases.
2. Create a new database called "`ABCTrading`".
3. Set the "`ABCTrading`" database as the default database.
4. Show all the tables in the default database.
5. Create a new table called "`products`" with the columns and type indicated below.

```
+-------+----------+-------------+----------+---------+
| id    | category | name        | quantity | price   |
| (INT) | CHAR(3)  | VARCHAR(20) | (INT)    | (FLOAT) |
+-------+----------+-------------+----------+---------+
| 1001  | PEN      | Pen Red     |     5000 |  1.23   |
| 1002  | PEN      | Pen Blue    |     8000 |  1.25   |
| 1003  | PEN      | Pen Black   |     2000 |  1.25   |
| 1004  | PCL      | Pencil 2B   |    10000 |  0.49   |
| 1005  | PCL      | Pencil 2H   |     9000 |  0.48   |
+-------+----------+-------------+----------+---------+
```

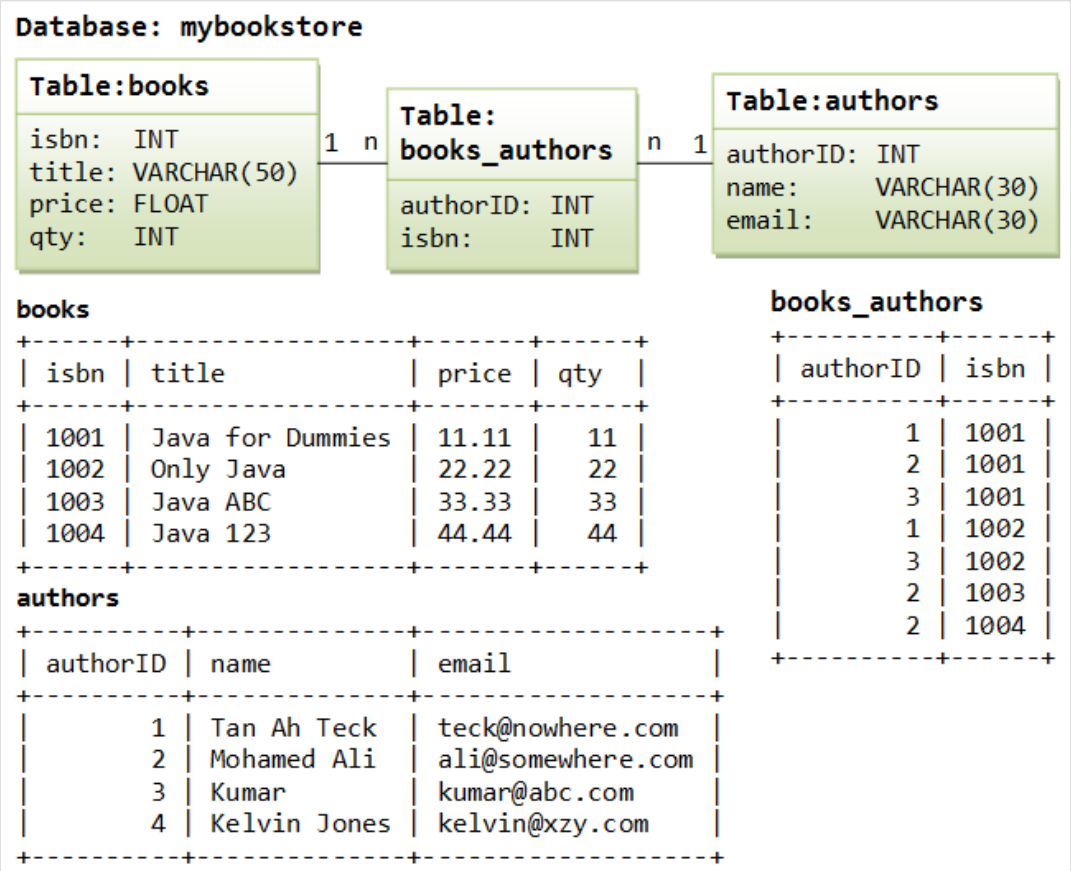
6. Show the table description.
7. Insert the above records and list all the records.
8. List records with name containing "`Pencil`".
9. List records with price ≥ 1.0.
10. Increase the price of all items by 10%, and list all the records.
11. Remove "Pen Red" from the table, and list all the records.

4. Many-to-many Relationship

In a bookstore, a book is written by one or more authors; an author may write zero or more books. This is known as a *many-to-many relationship*. It is IMPOSSIBLE to capture many-to-many relationship in a SINGLE table (or a spreadsheet) with a fixed number of columns, without duplicating any piece of information! For example, if you organize the data in the table below, you will not know how many author columns to be used; and you need to repeat all the data for repeating authors.

Book-name	Author1-name	Author1-email	Author2-name	Author2-email	???
Java 123 SQL ABC SQL 123	Peter Peter Peter	pt@abc.com pt@abc.com pt@abc.com	John Paul	jj@abc.com pp@abc.com	....

The many-to-many relationship between books and authors can be modeled with 3 tables, as shown below. A `books` table contains data about books (such as title and price); an `authors` table contains data about the authors (such as name and email). A table called `books_authors` joins the `books` and `authors` tables and captures the *many-to-many* relationship between `books` and `authors`.



Exercises

1. Create a database called "`mybookstore`".
2. Use "`mybookstore`" as the default database.
3. Create 3 tables "`books`", "`authors`", and "`books_authors`" in the database "`mybookstore`", with column names and types as shown in the database diagram.
4. Insert the respective records into the tables, and list the contents of each of the tables.
5. Try this query and explain the output:

```
SELECT books.title, books.price, authors.name
   FROM books, books_authors, authors
   WHERE books.isbn = books_authors.isbn
      AND authors.authorID = books_authors.authorID
      AND authors.name = 'Tan Ah Teck';
```

6. List all the books (`title`, `price`, `qty`) by "Tan Ah Teck" with `price` less than `20`.
7. List all the authors (`name` and `email`) for the book title "Java for Dummies".
8. List all the books (`title`, `price`, `qty`) and all the authors (`name` and `email`) for books with title beginning with "Java" (Hints:

```
    title LIKE 'Java%');
```

5. (Optional) Backup and Restore Databases

5.1 Backup via "mysqldump" Utility Program

You can use the "mysqldump" utility program to back up (i) the entire server (all databases), (ii) selected databases, or (ii) selected tables of a database. The "mysqldump" program generates a SQL script that can later be executed to re-create the databases, tables and their rows.

For example, the following command backups the entire "studentdb" database to a SQL script called "backup_studentdb.sql".

For Windows

```
-- Start a NEW "cmd"
c:
cd \myWebProject\mysql\bin
mysqldump -u myuser -p --databases studentdb > "c:\myWebProject\backup_studentdb.sql"
```

For Mac OS X

```
-- Start a NEW "terminal"
cd /usr/local/mysql/bin
./mysqldump -u myuser -p --databases studentdb > ~/myWebProject/backup_studentdb.sql
     // ~ denotes the home directory of the current login user
```

Study the output file, which contains CREATE DATABASE, CREATE TABLE and INSERT statements to re-create the database and tables dumped earlier.

5.2 Restore via "source" command in a mysql client

You can restore from the backup by running the "source" command in a MySQL client. For example, to restore the studentdb backup earlier:

For Windows

```
-- Start a MySQL client
c:
cd \myWebProject\mysql\bin
mysql -u myuser -p
-- Run the backup script to recreate the database
mysql> drop database if exists studentdb;
mysql> source c:\myWebProject\backup_studentdb.sql
```

For Mac OS X

```
-- Start a MySQL client
cd /usr/local/mysql/bin
./mysql -u myuser -p
-- Run the backup script to recreate the database
mysql> drop database if exists studentdb;
mysql> source ~/myWebProject/backup_studentdb.sql
```

6. Summary of Frequently-Used Commands

(For Windows) Starting MySQL Server and Client

```
-- Start the Server
cd path-to-mysql-bin
mysqld --console

-- Shutdown the Server
Ctrl-c

-- Start a Client
cd path-to-mysql-bin
mysql -u username -p
```

(For Mac OS X) Starting MySQL Server and Client

```
-- Start/shutdown the Server:
-- Use Graphical Control

-- Start a Client
cd /usr/local/mysql/bin
./mysql -u username -p
```

Frequently-used MySQL Commands

MySQL commands are NOT case sensitive.

```
-- General
;           -- Sends command to server for processing (or \g)
\c          -- Cancels (aborts) the current command

-- Database-level
DROP DATABASE databaseName;                 -- Deletes the database
DROP DATABASE IF EXISTS databaseName;       -- Deletes only if it exists
CREATE DATABASE databaseName;               -- Creates a new database
CREATE DATABASE IF NOT EXISTS databaseName; -- Creates only if it does not exists
SHOW DATABASES;                             -- Shows all databases in this server

-- Set default database.
-- Otherwise you need to use the fully-qualified name, in the form
--   of "databaseName.tableName", to refer to a table.
USE databaseName

-- Table-level
DROP TABLE tableName;
DROP TABLE IF EXISTS tableName;
CREATE TABLE tableName (column1Definition, column2Definition, ...);
CREATE TABLE IF NOT EXISTS tableName (column1Definition, column2Definition, ...);
SHOW TABLES;              -- Shows all the tables in the default database
DESCRIBE tableName;       -- Describes the columns for the table
DESC tableName;           -- Same as above

-- Record-level (CURD - create, update, read, delete)
INSERT INTO tableName VALUES (column1Value, column2Value,...);
INSERT INTO tableName (column1Name, ..., columnNName)
   VALUES (column1Value, ..., columnNValue);
DELETE FROM tableName WHERE criteria;
UPDATE tableName SET columnName = expression WHERE criteria;
SELECT column1Name, column2Name, ... FROM tableName
   WHERE criteria
   ORDER BY columnAName ASC|DESC, columnBName ASC|DESC, ...;

-- Running a script of MySQL statements
SOURCE full-Path-Filename
```

Link to MySQL References & Resources

Latest version tested: MySQL Community Server 5.7.21, Windows 10 (1709), Mac OS X 10.13, Ubuntu 16.04LTS
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