DATABASE SYSTEMS

Introduction to MySQL

Database System Course, 2016

AGENDA FOR TODAY

- **Administration**
- **Database Architecture on the web**
- **Database history in a brief**
- **Databases today**
- **MySQL**
  - What is it
  - How to use it
- **Homework**

AGENDA (EXTENDED)

- **Administration**
- **Database Architecture (recap?)**
  - Database as a software
  - Database as a server
  - Database in the context of a web application
- **Database history in a brief**
- **Databases today:** RDBMS,Columnar,RDF ,Documents database
- **MySQL**
    - Introduction and History
    - Schema
    - How to connect remotely (SSH, different clients)
    - How to install locally (Xampp/MySql workbench/Phpmyadmin)
    - Executing queries

ADMINISTRATION

- **Course website:** http://courses.cs.tau.ac.il/0368-3458/databases201516
- **My Email:** (in the website)
- **TDBSoverflow:** Our new q&a platform:
  - http://www.cs.tau.ac.il/~amitsome/dbforum/index.php
  - Works like stackoverflow
  - Material related questions will not be answered elsewhere.
  - **Final grade bonus**: will be given to the top 5 users in the forum (rank): [2,2,3,3,5] for [5th,4th,3rd,2nd,1st)

ADMINISTRATION

Homework Submission

- Submission date is on the website.. (No late arrivals will be accepted)
- Work should be done in pairs
- Submission is done via moodle, by one of the partners
- Submit a zip file, with
  - an answers pdf that contains the full names and IDs of both partners on top of the page
  - A .sql file for every query. **Make sure it's runnable.**

ADMINISTRATION

The final project

- It's really useful and practical (now more than ever)
- Work in groups of 4-5.
- Project goal: to build a full-fledged web based application while tackling a real-life DB related development issue.
- One Milestone (see dates on the website)
- Using PHP or Python.

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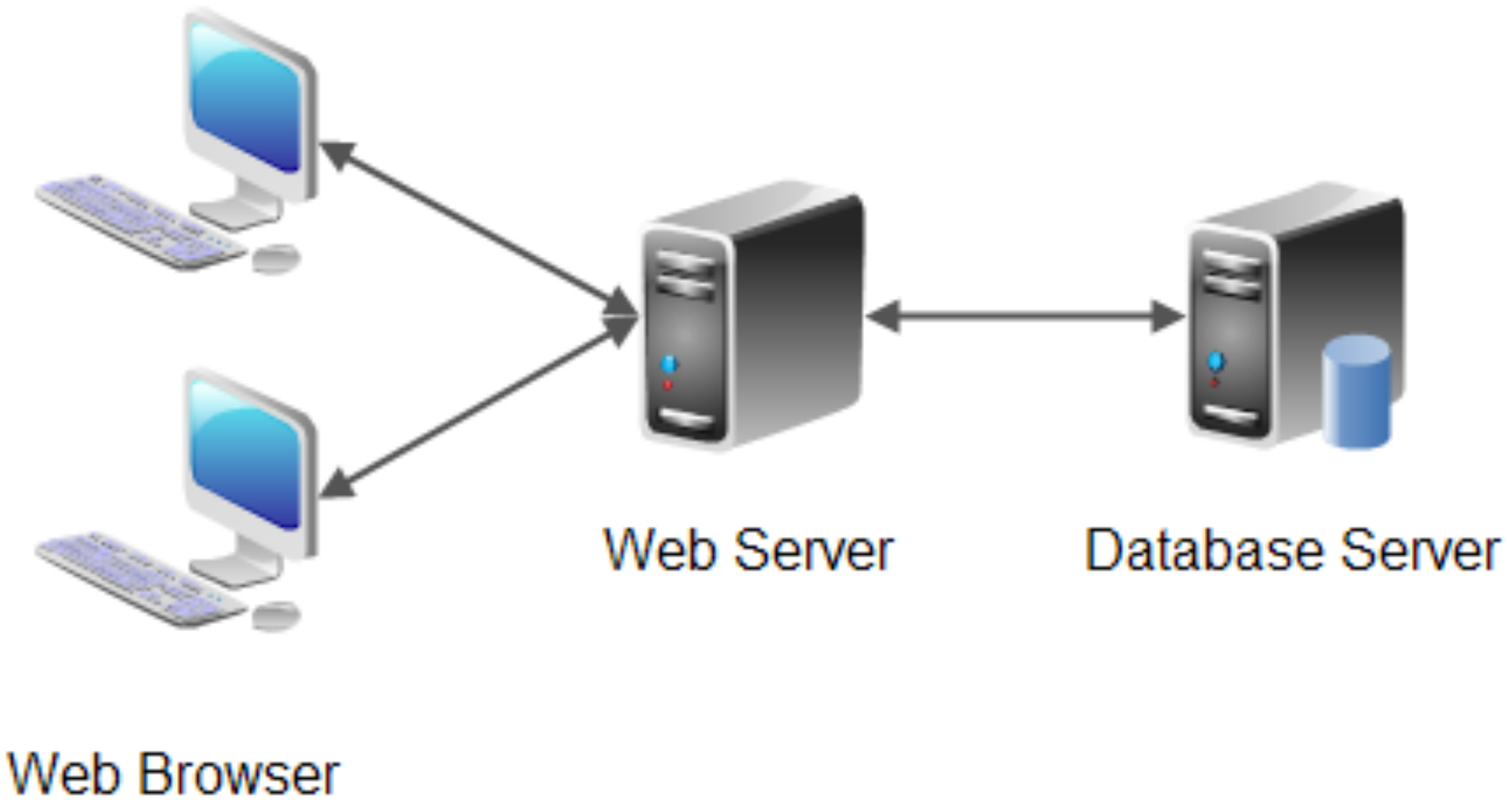
DATABASE ARCHITECTURE ON THE WEB (BRIEF)

- Database server is a **standalone** server.
- Database server is not accessible to web-users (when configured securely)
- Only the web server communicates with the DB.
- Administrators have special permissions to access to the database management system directly.

DATABASE ARCHITECTURE ON THE WEB (ILLUSTRATION)



DATABASE ARCHITECTURE ON THE WEB (EXTENDED)

- Database is a process, running within an operation system on a physical or virtual server.
- When running, the data base software process binds a listening network port on a local interface.
- A web server is also a process, binding a listing port.
- **Security configuration (e.g. in a Firewall)**

  Only the web server is allowed to connect to the DB port.

  Administrator user is allowed to connect to the DB port directly (in a secured connection, like you soon….^_^)

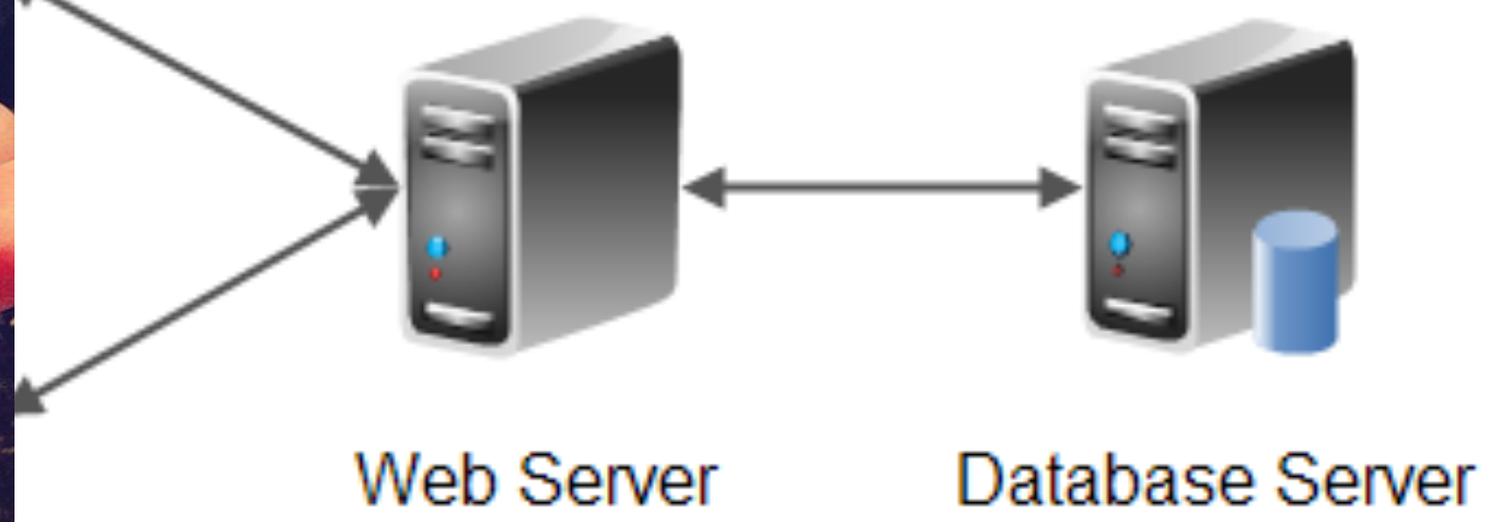
  The web server is open to web-users.

DATABASE ARCHITECTURE ON THE WEB (EXTENDED)

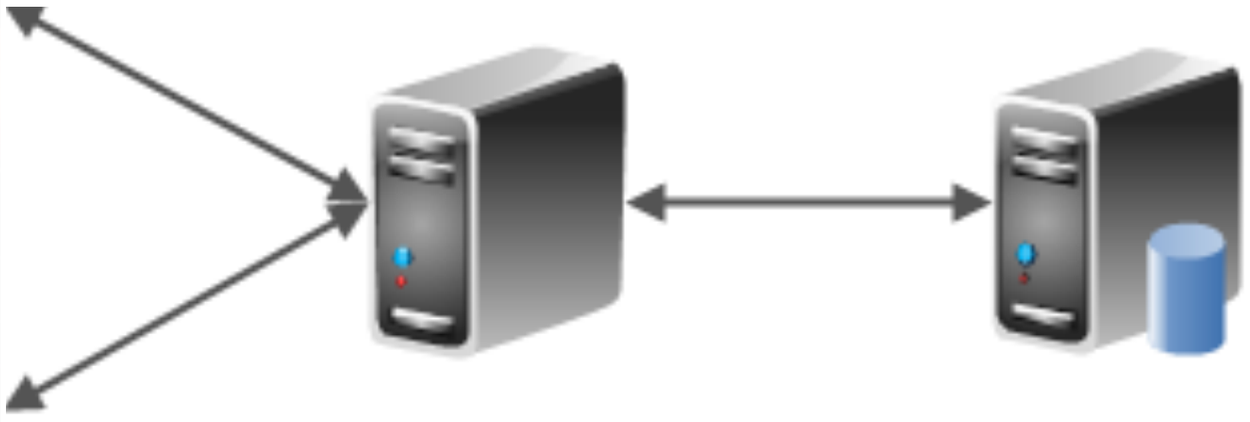
- **Web session illustration in 6 simple stages**

1. A client opens a web browser in her computer
2. Within the web browser she type the URL of a website (e.g. ynet.co.il)
3. The browser issues an HTTP session to request the website's content.
4. The web server receive the HTTP request
5. The web server connects to the DB server to retrieve data (e.g., current articles of today)
6. The web server returns the client the content of the page.

HOW DOES INSTAGRAM WORKS?



HOW DOES INSTAGRAM WORKS?



Web Server

Database Server

★ Image Processing
★ UI operations

★ Authentication
★ Notifications
★ API

★ Images table
★ Users table

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- Administration
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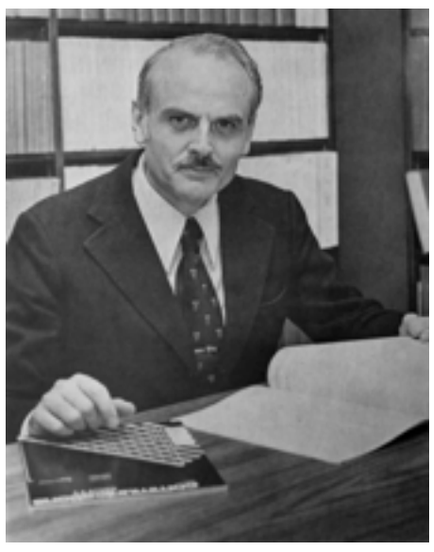
DATABASE HISTORY

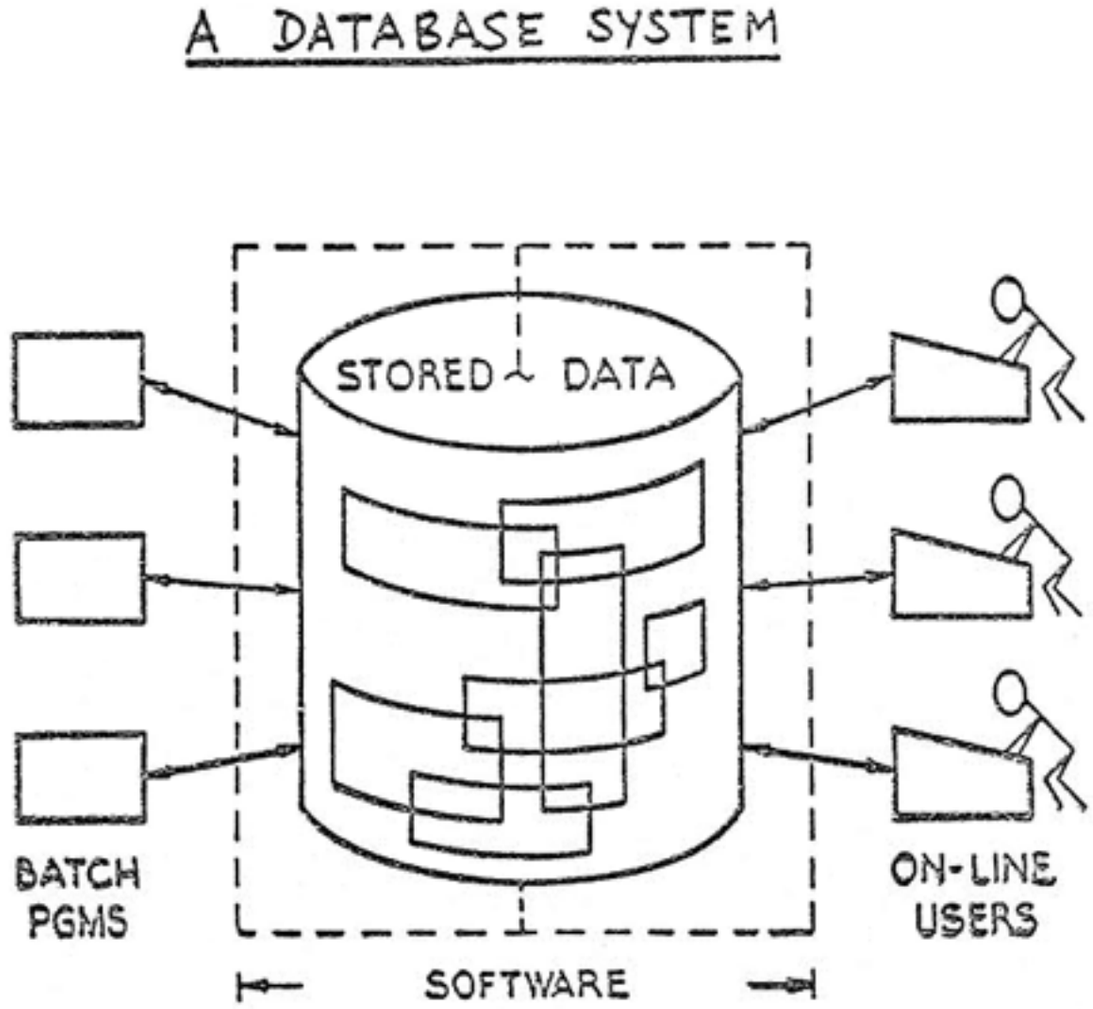
- **1966 IBM: Information Management System**
  - Designed for the Apollo space program, to store inventory, components and matterals for Saturn V rocket. It was running on an IBM mainframe computer.
  - IMS was a **hierarchical database**, relying on the "manual" navigation of a linked data set which was formed into a large network. Applications could find records by one of three methods:

1. Use of a primary key (known as a CALC key, typically implemented by hashing)
2. Navigating relationships (called sets) from one record to another
3. Scanning all the records in a sequential order

DATABASE HISTORY

- **1970 The relational model (theoretical)**
  - Mechanical hard drives invented
  - It's sucks to search in the hierarchical DB,
  - Invented by Edgar Codd from IBM
- **1974 IBM "System R"**
  - R is for relational.
  - First implementation of SQL
  - Proving the performance and usability of the relational model





DATABASE HISTORY

- **1980 Personal Databases**
  - Desktops are introduced to the world
  - People use spread-sheet software Like IBM Lotus

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Worksheet Range Copy Move File Print Graph Data System Quit
Global Insert Delete Column Erase Titles Window Status Page Hide

	A	B	C	D	E	F	G
1	EMP	EMP_NAME	DEPTNO	JOB	YEARS	SALARY	BONUS
2	1777	Azibad	4000	Sales	2	40000	10000
3	81964	Brown	6000	Sales	3	45000	10000
4	40370	Burns	6000	Mgr	4	75000	25000
5	50706	Caeser	7000	Mgr	3	65000	25000
6	49692	Curly	3000	Mgr	5	65000	20000
7	34791	Dabarrett	7000	Sales	2	45000	10000
8	84984	Daniels	1000	President	8	150000	100000
9	59937	Dempsey	3000	Sales	3	40000	10000
10	51515	Donovan	3000	Sales	2	30000	5000
11	48338	Fields	4000	Mgr	5	70000	25000
12	91574	Fiklore	1000	Admin	8	35000	---
13	64596	Fine	5000	Mgr	3	75000	25000
14	13729	Green	1000	Mgr	5	90000	25000
15	55957	Hernann	4000	Sales	4	50000	10000
16	31619	Hodgedon	5000	Sales	2	40000	10000
17	1773	Howard	2000	Mgr	3	80000	25000
18	2165	Hugh	1000	Admin	5	30000	---
19	23907	Johnson	1000	VP	1	100000	50000
20	7166	Laflare	2000	Sales	2	35000	5000

DATA.WK3

DATABASE TODAY

- **Distributed RDBMS**
  - **Apacehe Hadoop**
  - **Map Reduce:** (2 stages: first "Map" a job to a node then "Reduce", where each node process and return
- **In memory RDBMS**
  - **Apache SPARK** is both distributed and uses fast in-memory computations
- **NO-SQL**
  - Non sql data stores , e.g. Graph storages, Key-value (like "dictionaries" in Python)
- **Columnar Databases:**

  Stores columns instead of rows

  Useful for data cubes and aggregations

  Becoming less popular because of the "in-memory" analytics nowadays

DATABASES TODAY

Rank			DBMS	Database Model	Score		
Mar 2016	Feb 2016	Mar 2015			Mar 2016	Feb 2016	Mar 2015
1.	1.	1.	Oracle	Relational DBMS	1472.01	-4.13	+2.93
2.	2.	2.	MySQL	Relational DBMS	1347.71	+26.59	+86.62
3.	3.	3.	Microsoft SQL Server	Relational DBMS	1136.49	-13.73	-28.31
4.	4.	4.	MongoDB	Document store	305.33	-0.27	+30.32
5.	5.	5.	PostgreSQL	Relational DBMS	299.62	+10.97	+35.19
6.	6.	6.	DB2	Relational DBMS	187.94	-6.55	-10.91
7.	7.	7.	Microsoft Access	Relational DBMS	135.03	+1.95	-6.66
8.	8.	8.	Cassandra	Wide column store	130.33	-1.43	+23.02
9.	↑ 10.	↑ 10.	Redis	Key-value store	106.22	+4.14	+9.17
10.	↓ 9.	↓ 9.	SQLite	Relational DBMS	105.77	-1.01	+4.06
11.	↑ 12.	↑ 15.	Elasticsearch	Search engine	80.17	+2.33	+21.24
12.	↓ 11.	↓ 11.	SAP Adaptive Server	Relational DBMS	76.64	-3.39	-8.72
13.	13.	13.	Teradata	Relational DBMS	74.07	+0.69	+1.29
14.	14.	↓ 12.	Solr	Search engine	69.37	-2.91	-12.52
15.	↑ 16.	↓ 14.	HBase	Wide column store	52.41	+0.39	-8.32
16.	↓ 15.	↑ 17.	Hive	Relational DBMS	50.51	-2.26	+11.18
17.	17.	↓ 16.	FileMaker	Relational DBMS	47.93	+0.90	-4.41
18.	18.	↑ 19.	Splunk	Search engine	43.73	+0.90	+8.01
19.	19.	↑ 21.	SAP HANA	Relational DBMS	39.99	+1.91	+7.82
20.	↑ 21.	↑ 23.	Neo4j	Graph DBMS	32.36	+0.07	+4.73

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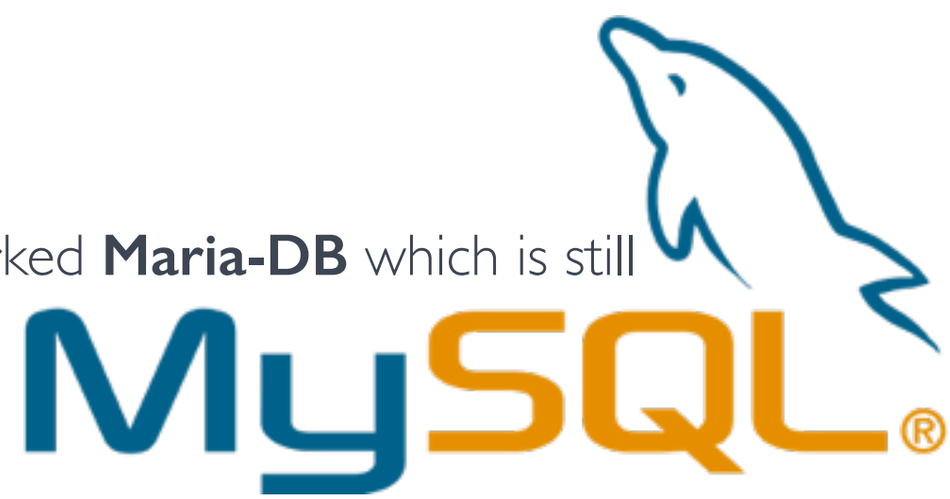
MYSQL: INTRODUCTION

- **What is MySQL?**
  - A relational database management system (RDBMS)
  - Free and open-source software written in C and C++
- **Why do we learn MySQL?**
  - It's the most common database in the web (client-server model)
  - Uses by: Facebook, Google, Twitter,
  - Is super simple (comparing to Oracle, PostgreSQL)
- **3 things you (maybe) didn't know about MySQL**
  - First version was out on 1995
  - It is actually owned by Oracle, since 2010
  - When it happened, one of the founders quit and forked **Maria-DB** which is still free under the GNU license



MYSQL: CONNECT REMOTELY

- **SQL Clients**
  - CLI (command-line interface) for 1337 haxors
  - SQL Software (i.e. workbench)
  - PhpMyAdmin (web based)
- **For security reasons, connection is over SSH, remember?**

WAIT-A-MINUTE: SSH?

Secure Shell (SSH)

★A network (layer 7) protocol

★Providing secured channel to a remote host.

★Built-in client in Unix based systems

★Putty is required in Windows based systems.

MYSQL: CONNECT REMOTELY (+SSH)

Command line connection (unix)

- Establish SSH connection to nova

```
➜  ~ ssh amitsome@nova.cs.tau.ac.il
amitsome@nova.cs.tau.ac.il's password:
Last login: Mon Mar 14 22:44:02 2016 from 37.142.245.121
nova 1%
```

- Use Mysql CLI tool to connect to mysqlsrv.tau.ac.il

```
[nova 1% mysql -h mysqlsrv.cs.tau.ac.il -u sakila -p
[Enter password:
 Welcome to the MySQL monitor.  Commands end with ; or \g.
 Your MySQL connection id is 1368667
 Server version: 5.5.35-1ubuntu1-log (Ubuntu)
```

MYSQL: CONNECT REMOTELY (+SSH)

Command line connection (unix)

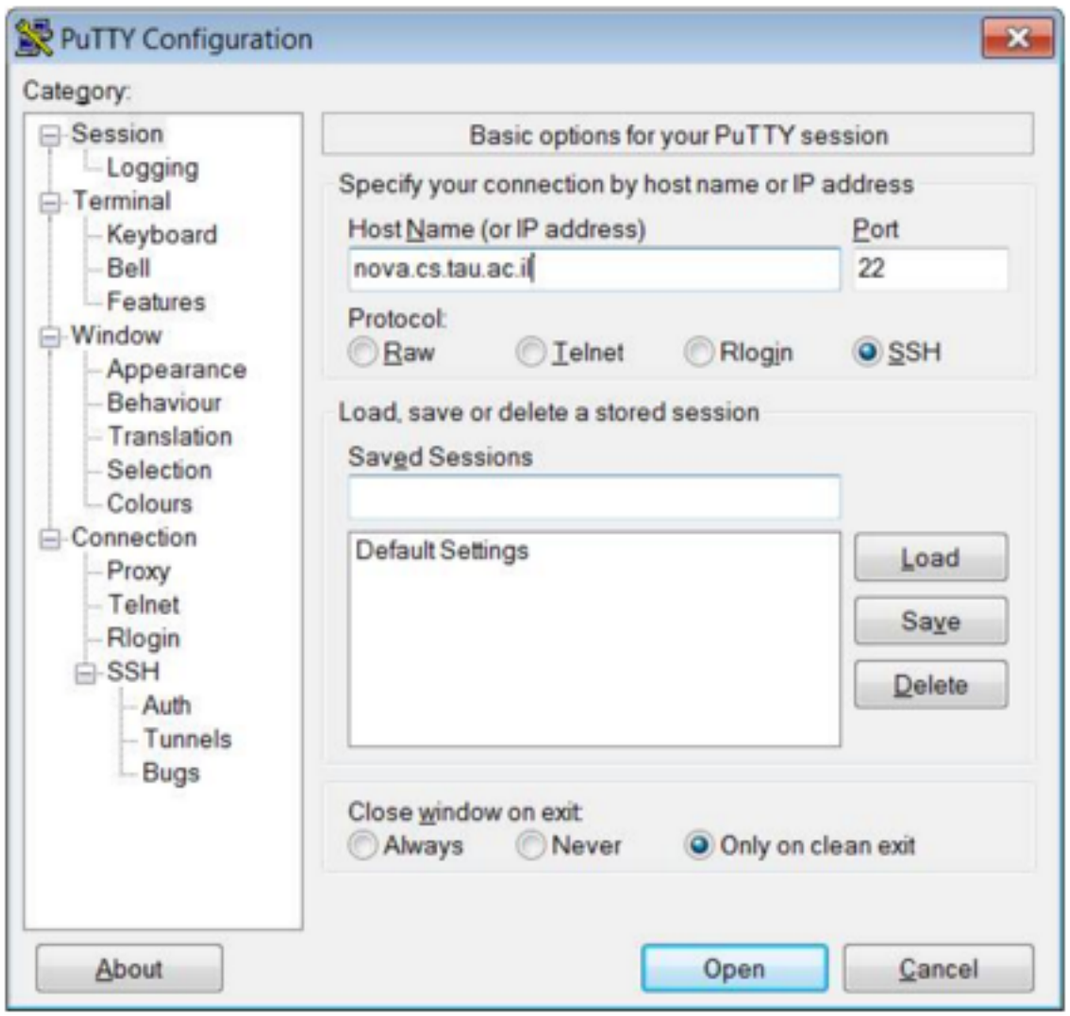
- Run queries for fun and profit.

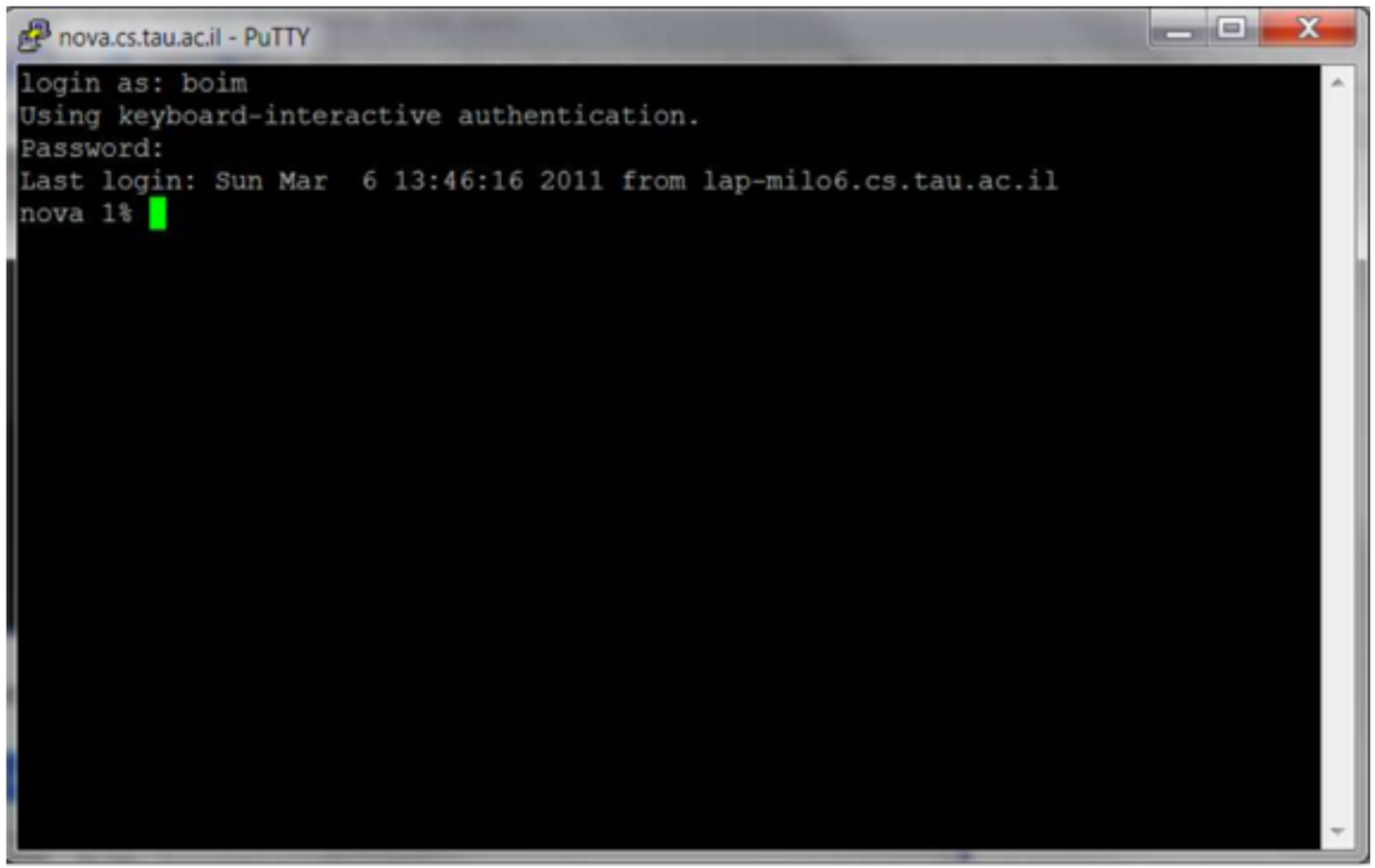
```
[mysql> select 1;
+---+
| 1 |
+---+
| 1 |
+---+
1 row in set (0.00 sec)
```

MYSQL: CONNECT REMOTELY (+SSH)

Command line connection (Windows)

Using Putty to Nova





MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

1. Download and install MySQL server for Windows from the official website, see the last slides for a step-by-step manual.

2. Read carefully the connection guide (here)

3. Establish a **Tunnel** in putty as usual

4. In the Tunnel configuration, add a **Port Forwarding rule**:

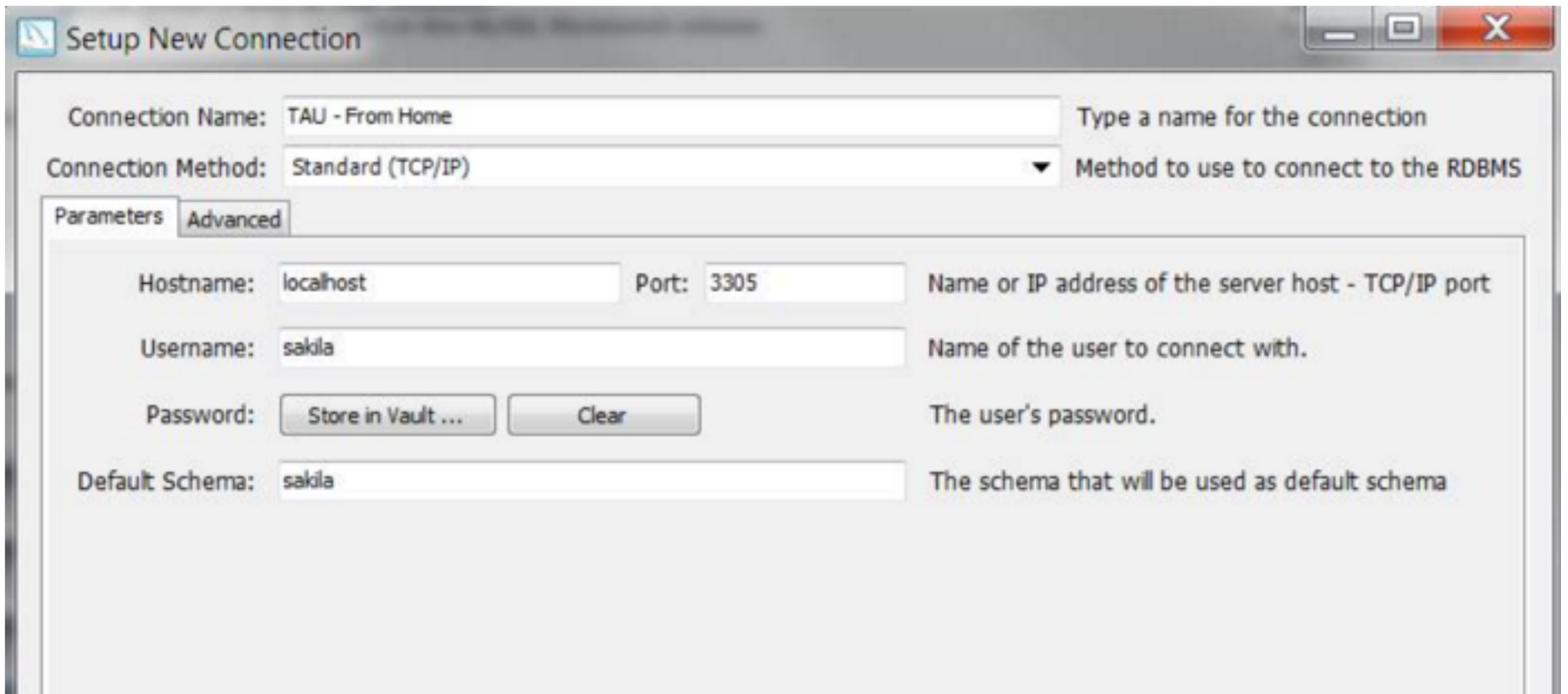
   - from local port 3305
   - to mysqlsrv.cs.tau.ac.il, port 3306

MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

4.Open Workbench, and create a new connection

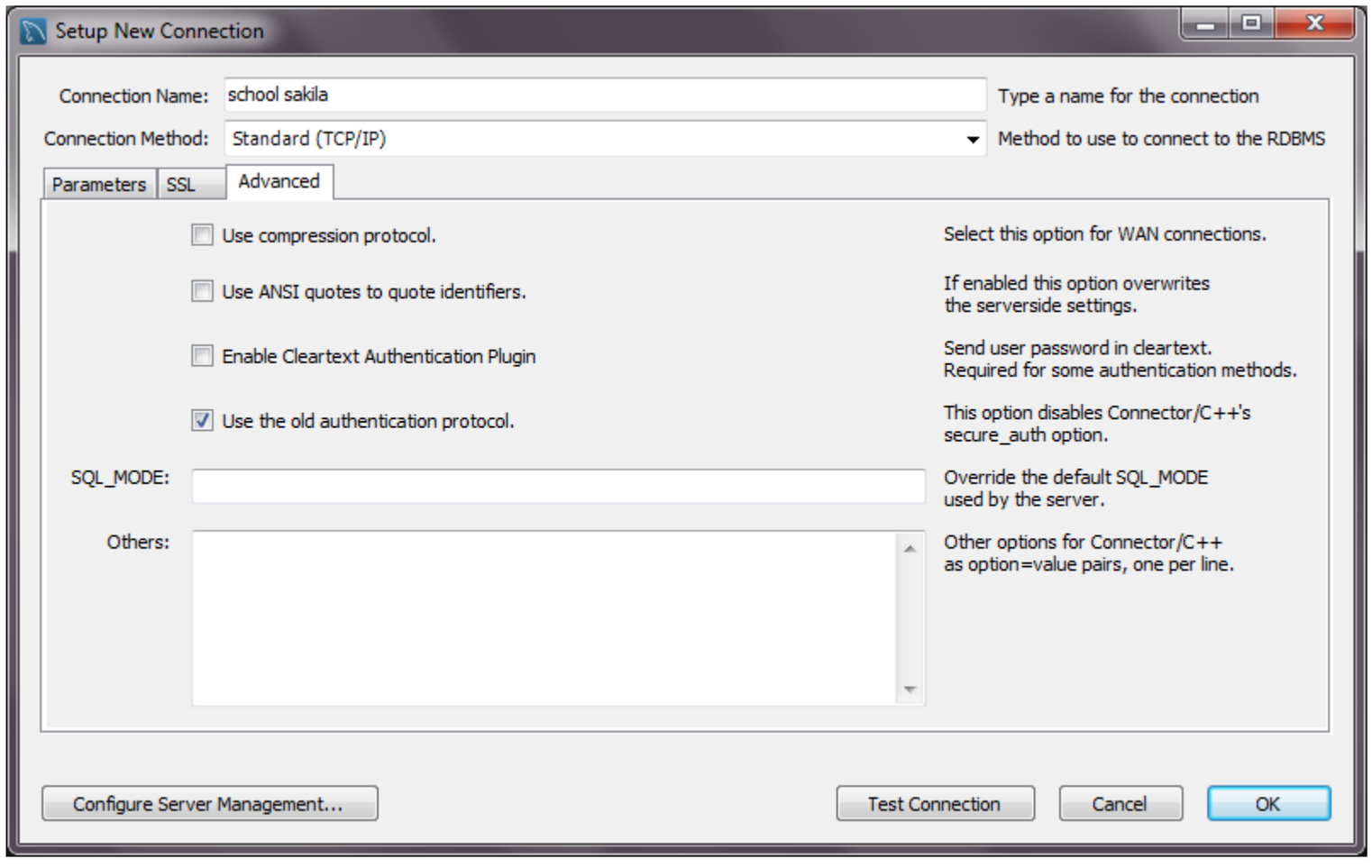
5.Configure the software to connect to your local host at port 3305 (instead of mysqlsrv.cs.tau.ac.il)



MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

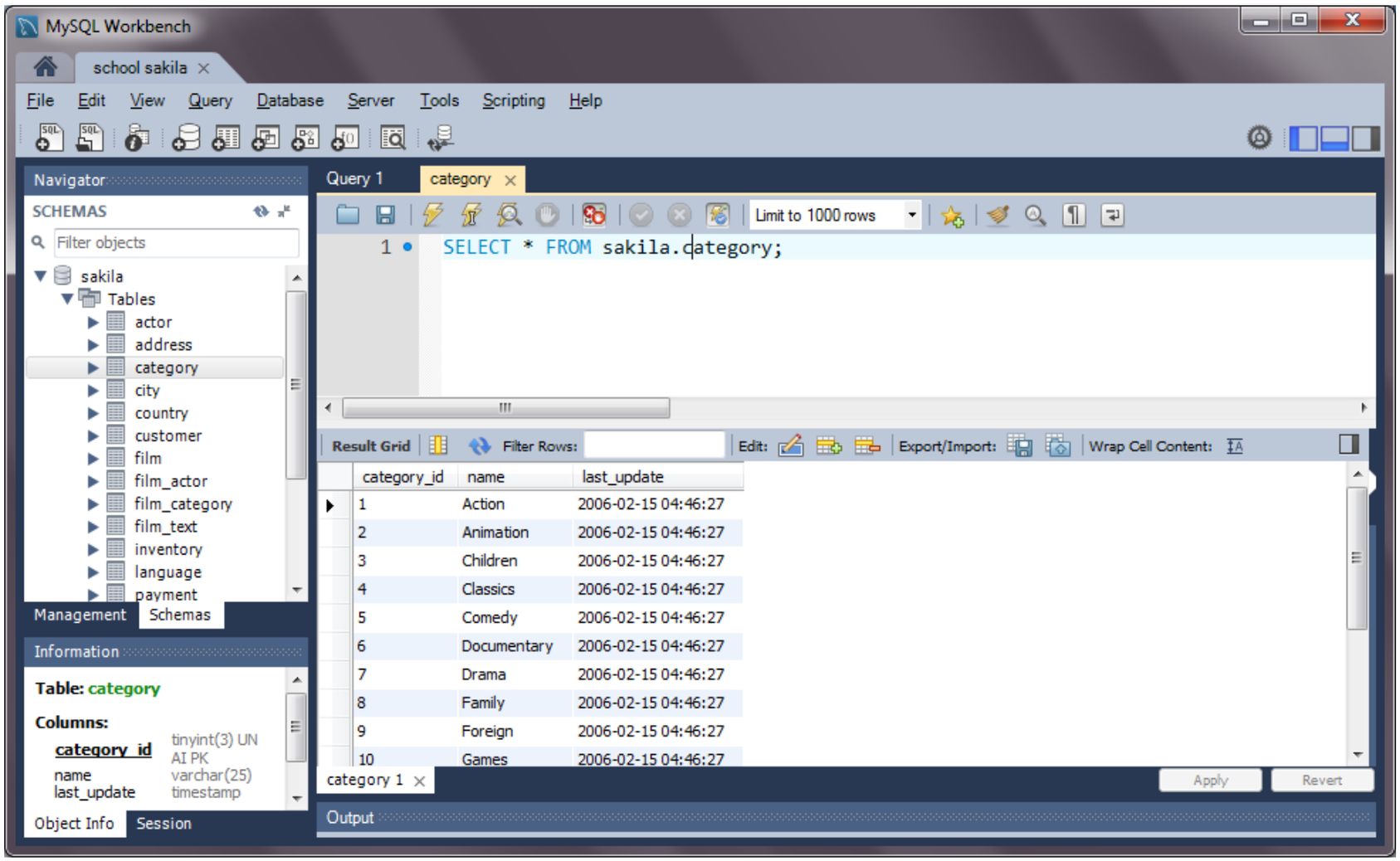
6. Support the old authentication protocol for some reason.



MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (Windows, the hard way)

7.Start querying for hw# 1



MYSQL: CONNECT REMOTELY (+SSH)

SQL Software (All platforms)

1. Install an SQL client that support SSH Tunnel

★Windows: Heidi SQL

★Mac: Sequel Pro

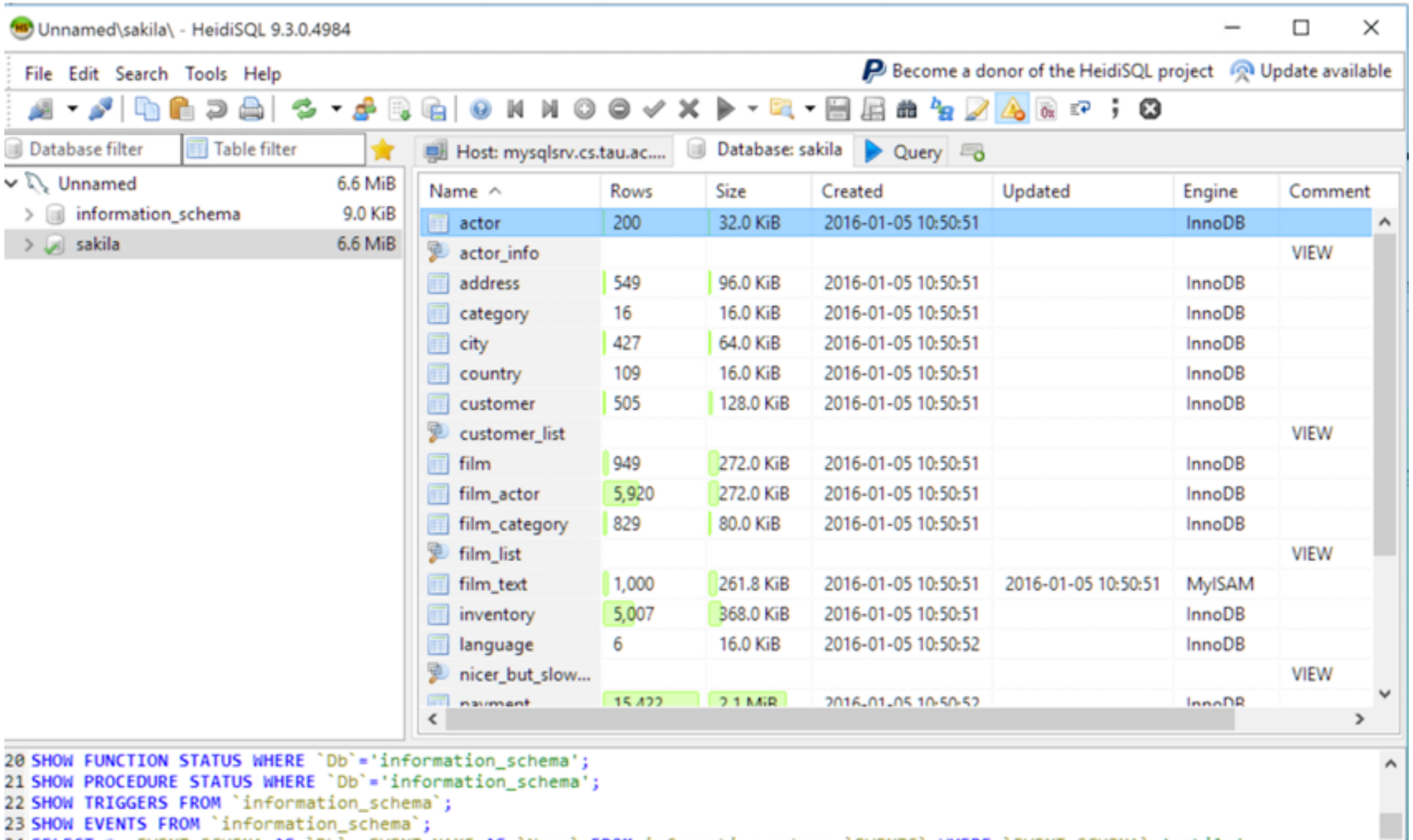
★ALL Platforms: DBeaver

2. Configure the SSH server in the option tab

3. Start querying

MYSQL: CONNECT REMOTELY (+SSH)

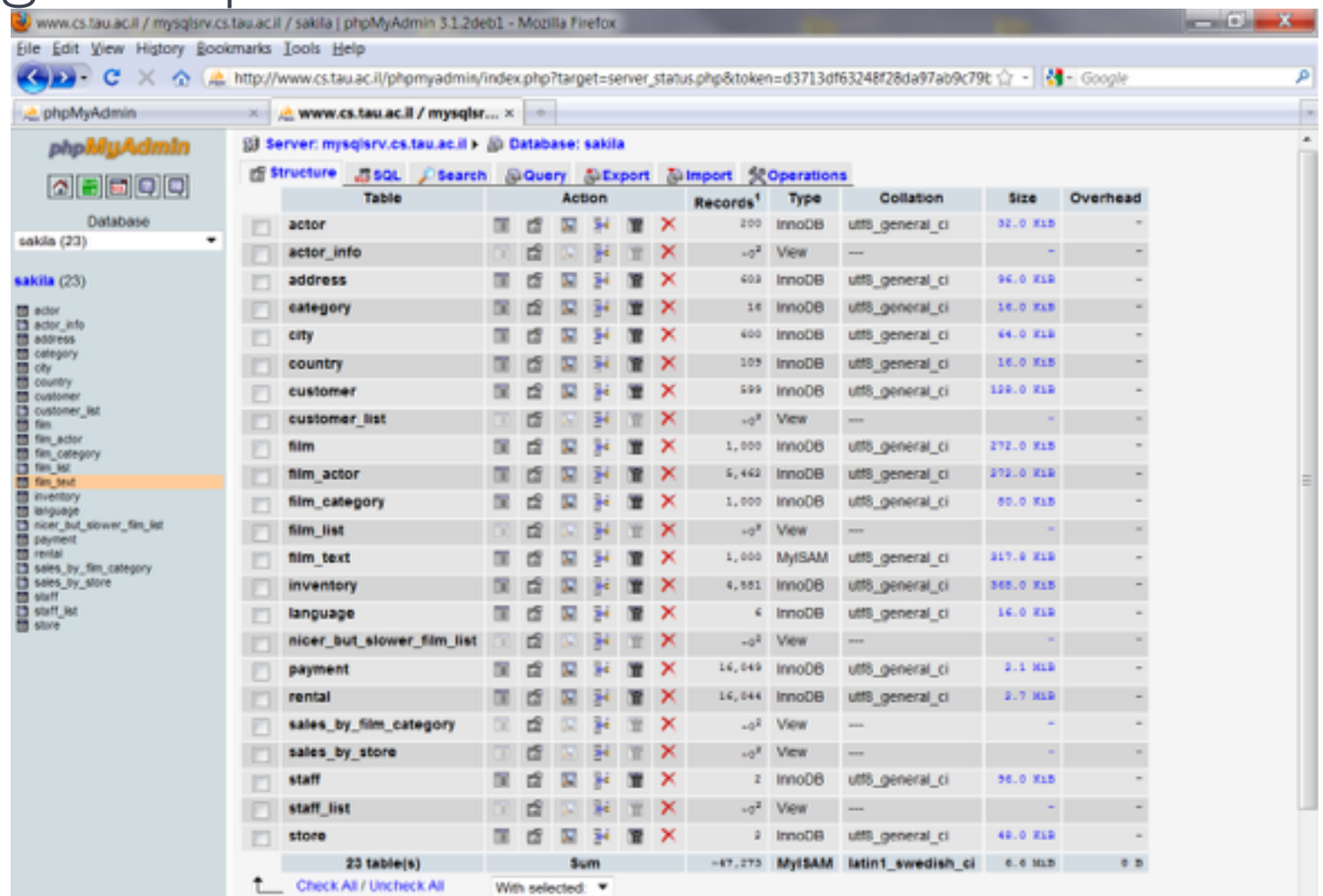
SQL Software (All platforms)



MYSQL: CONNECT REMOTELY

phpMyAdmin

Web based MySQL client, very common in shared hosting web platforms.



MYSQL: META-DATA

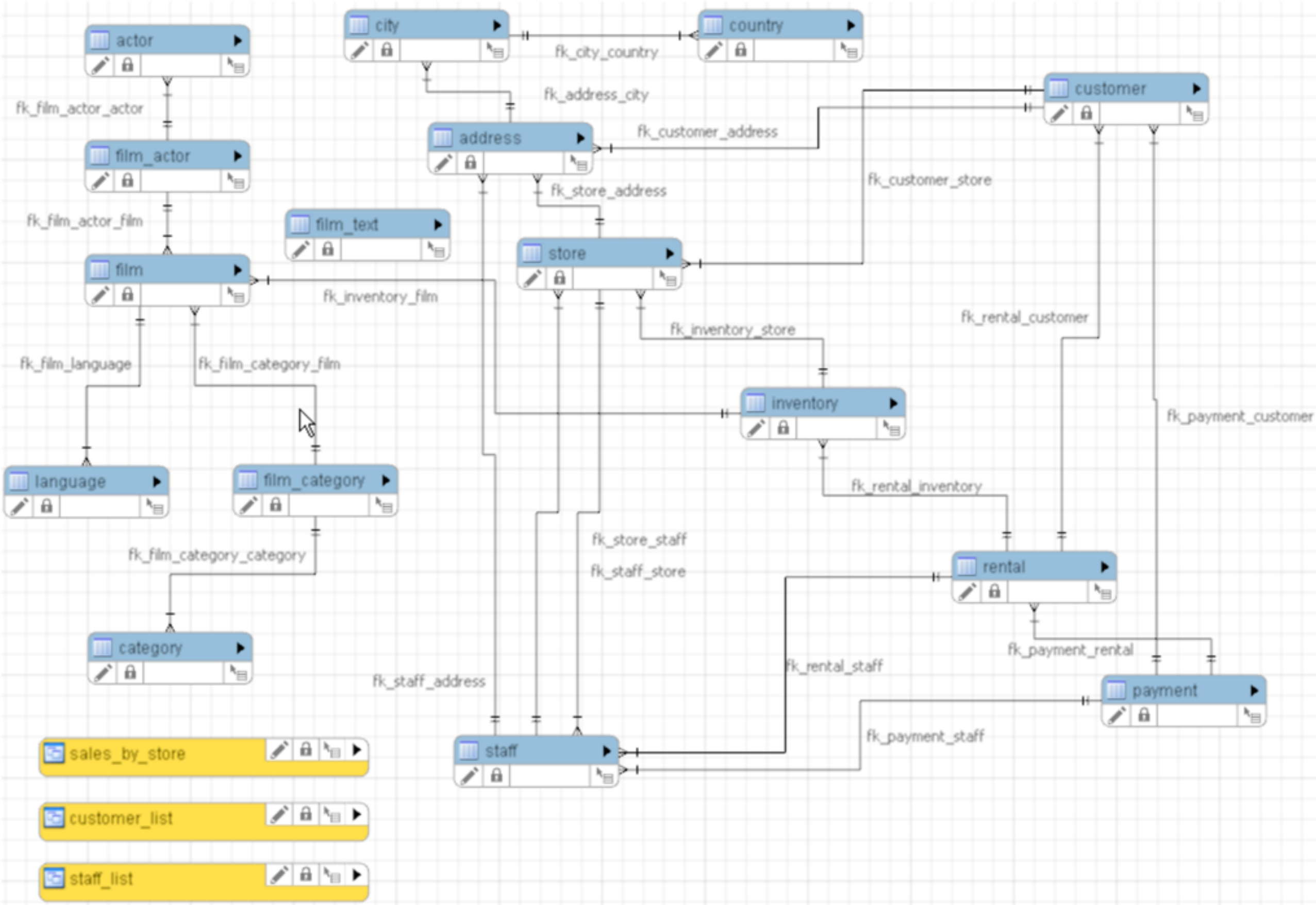
- **Information_schema**
  - MySQL server has a default database called "information_schema"
  - TABLES table contains information about each table in the database. e.g, name, type,number of rows etc.
  - COLUMNS table contains information about each column, such as the table it's belong to, the data type, etc.
  - USER_PRIVILEGES table contains information about the users listed in the database (do not confuse with web-users accessing the website.

MYSQL: META-DATA

- **MySQL Data types**
  - Each column has a predefined type and possibly a default value
    - ★ Integers: TINYINT, MEDIUMINT, BIGINT
    - ★ Strings: VARCHAR (strings), BLOB (for binaries)
    - ★ Dates: TIMESTAMP, DATE, DATETIME
  - Set when the database schema is created

MYSQL: META-DATA

- **MySQL users privileges**
  - Root user: granting permissions, creating users, altering creating and deleting data
  - Application users: usually read only, no grant.
  - Don’t every use root user in a DB connection string (we will discuss it over the next recitations)


actor
city
country
customer
address
film_actor
film_text
film
store
inventory
language
film_category
category
rental
payment
staff
sales_by_store
customer_list
staff_list
fk_city_country
fk_address_city
fk_customer_address
fk_film_actor_actor
fk_film_actor_film
fk_store_address
fk_customer_store
fk_inventory_film
fk_inventory_store
fk_rental_customer
fk_payment_customer
fk_film_language
fk_film_category_film
fk_film_category_category
fk_rental_inventory
fk_store_staff
fk_staff_store
fk_payment_rental
fk_rental_staff
fk_staff_address
fk_payment_staff

MYSQL: SAKILA SCHEMA

Example Query:

```
mysql> SELECT CONCAT(customer.last_name, ', ', customer.first_name) AS customer,
    -> address.phone, film.title
    -> FROM rental INNER JOIN customer ON rental.customer_id = customer.customer_id
    -> INNER JOIN address ON customer.address_id = address.address_id
-> INNER JOIN inventory ON rental.inventory_id = inventory.inventory_id
-> INNER JOIN film ON inventory.film_id = film.film_id
-> WHERE rental.return_date IS NULL
-> AND rental_date + INTERVAL film.rental_duration DAY < CURRENT_DATE()
-> LIMIT 5;
```

MYSQL: SAKILA SCHEMA

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    -> WHERE rental.return_date IS NULL
    -> AND rental_date + INTERVAL film.rental_duration DAY < CURRENT_DATE()
    -> LIMIT 5;
```

Results:

```
+------------------+-------------+-------------------+
| customer         | phone       | title             |
+------------------+-------------+-------------------+
| OLVERA, DWAYNE   | 62127829280 | ACADEMY DINOSAUR  |
| HUEY, BRANDON    | 99883471275 | ACE GOLDFINGER    |
| BROWN, ELIZABETH | 10655648674 | AFFAIR PREJUDICE  |
| OWENS, CARMEN    | 272234298332| AFFAIR PREJUDICE  |
| HANNON, SETH     | 864392582257| AFRICAN EGG       |
+------------------+-------------+-------------------+
```

MYSQL: SAKILA SCHEMA

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| OWENS, CARMEN    | 272234298332| AFFAIR PREJUDICE  |
| HANNON, SETH     | 864392582257| AFRICAN EGG       |
+------------------+-------------+-------------------+
```

YOUR BEST FRIENDS

- MySQL is the most common database used on the web.
- Therefore, **stackoverflow** is your friend.
- Another good friend you got : w3schools.com. for everything you need regarding web development and basic SQL use.
- MySQL cheatsheet:
  - https://en.wikibooks.org/wiki/MySQL/CheatSheet

Install MySQL at Home

- MySQL Community Server

  http://www.mysql.com/downloads/mysql/

Registration is Optional

Begin Your Download - mysql-installer-community-5.6.22.0.msi

Login Now or Sign Up for a free account.

An Oracle Web Account provides you with the following advantages:

- Fast access to MySQL software downloads
- Download technical White Papers and Presentations
- Post messages in the MySQL Discussion Forums
- Report and track bugs in the MySQL bug system
- Comment in the MySQL Documentation

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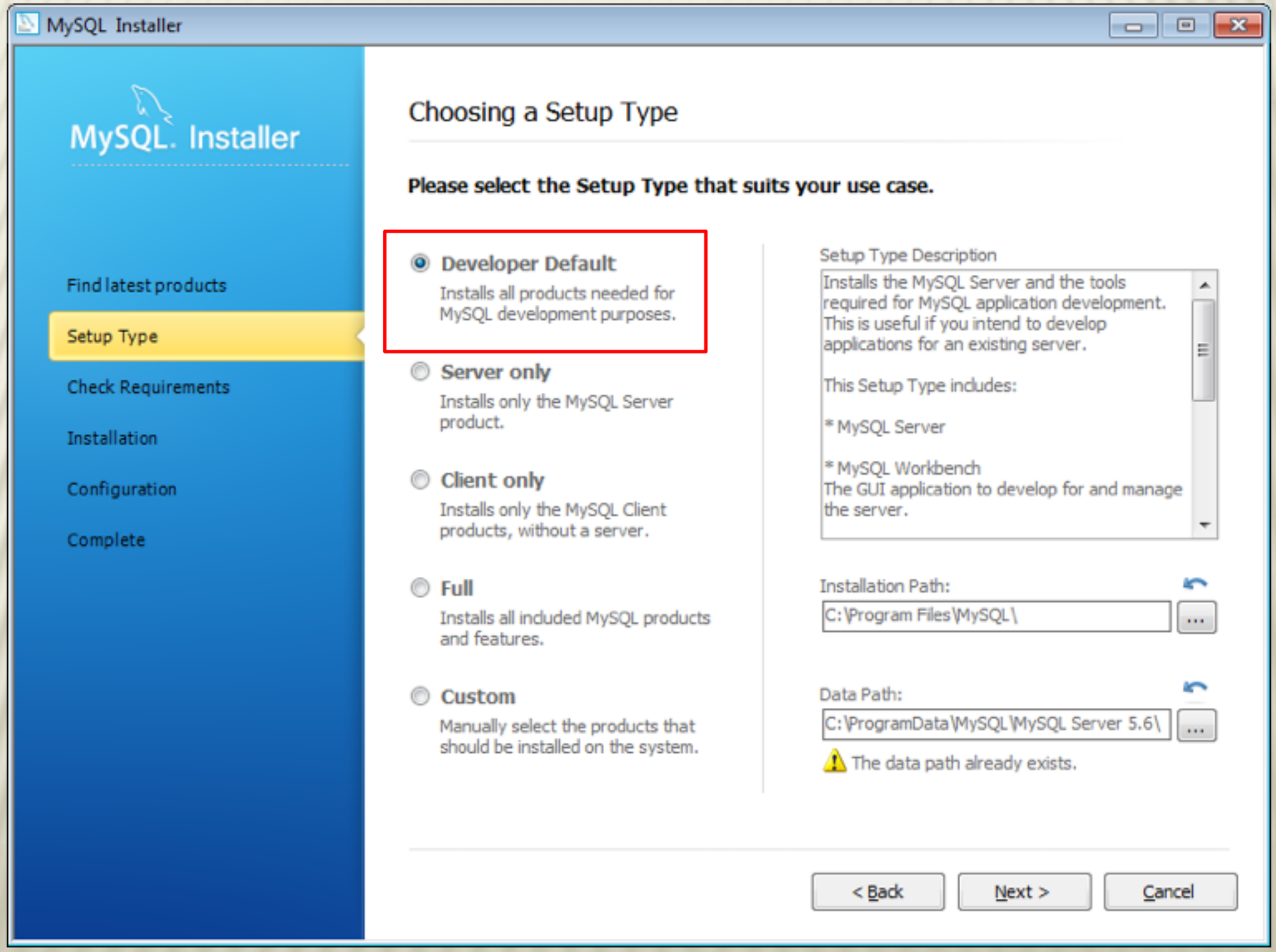
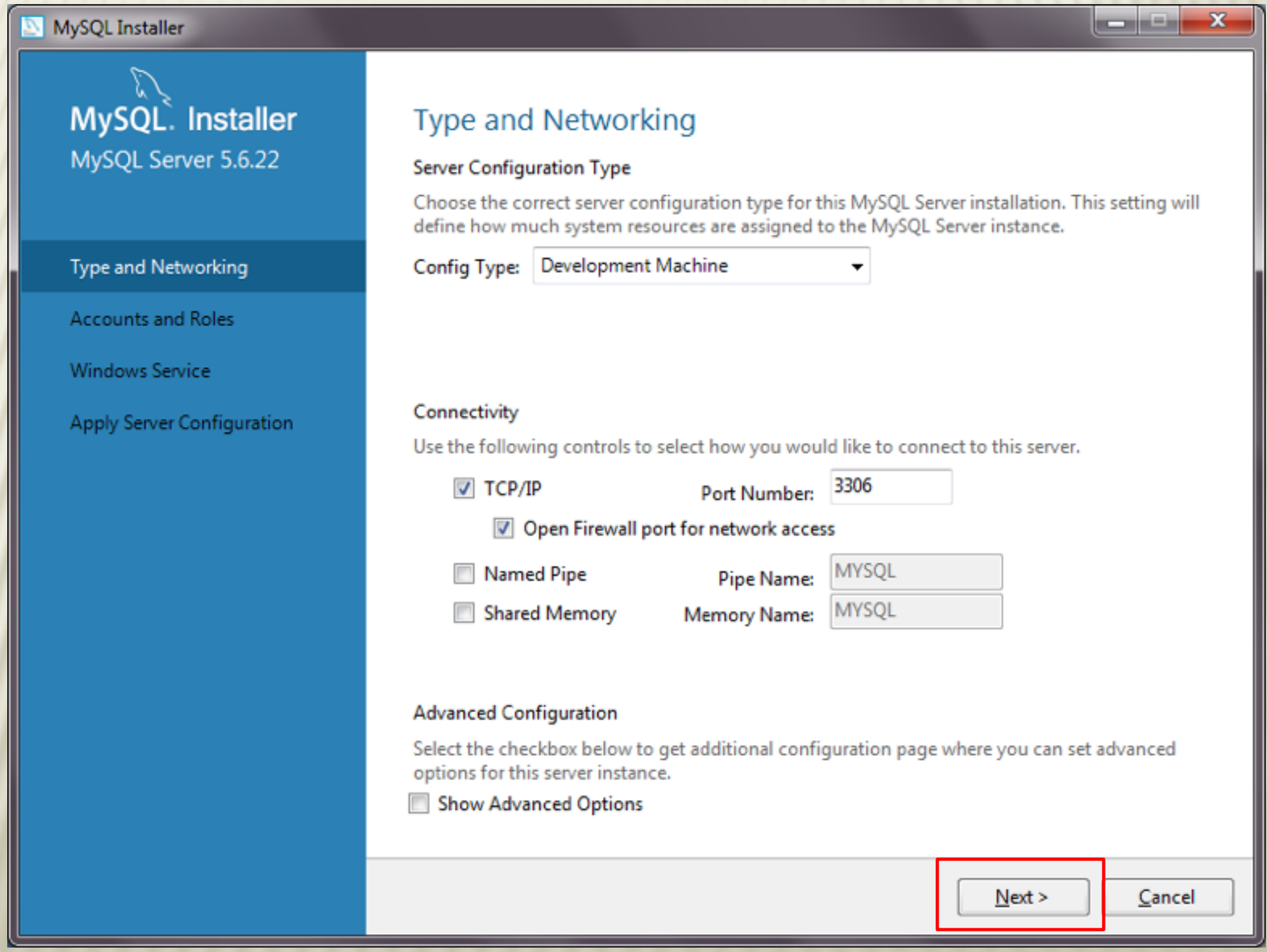
MySQL.com is using Oracle SSO for authentication. If you already have an Oracle Web account, click the Login link. Otherwise, link and following the instructions.

No thanks, just start my download.

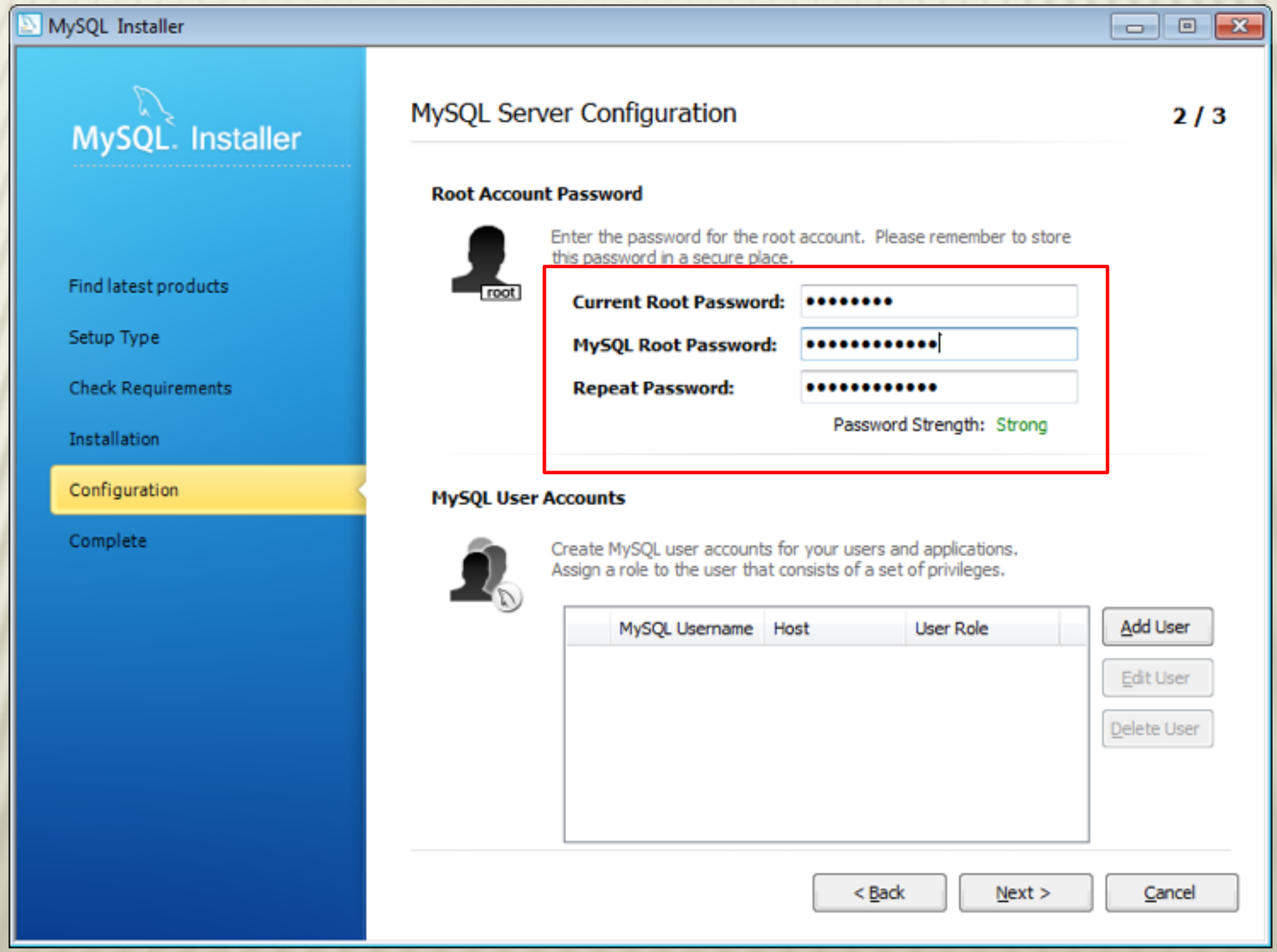
Installation using an Installer



Configuration

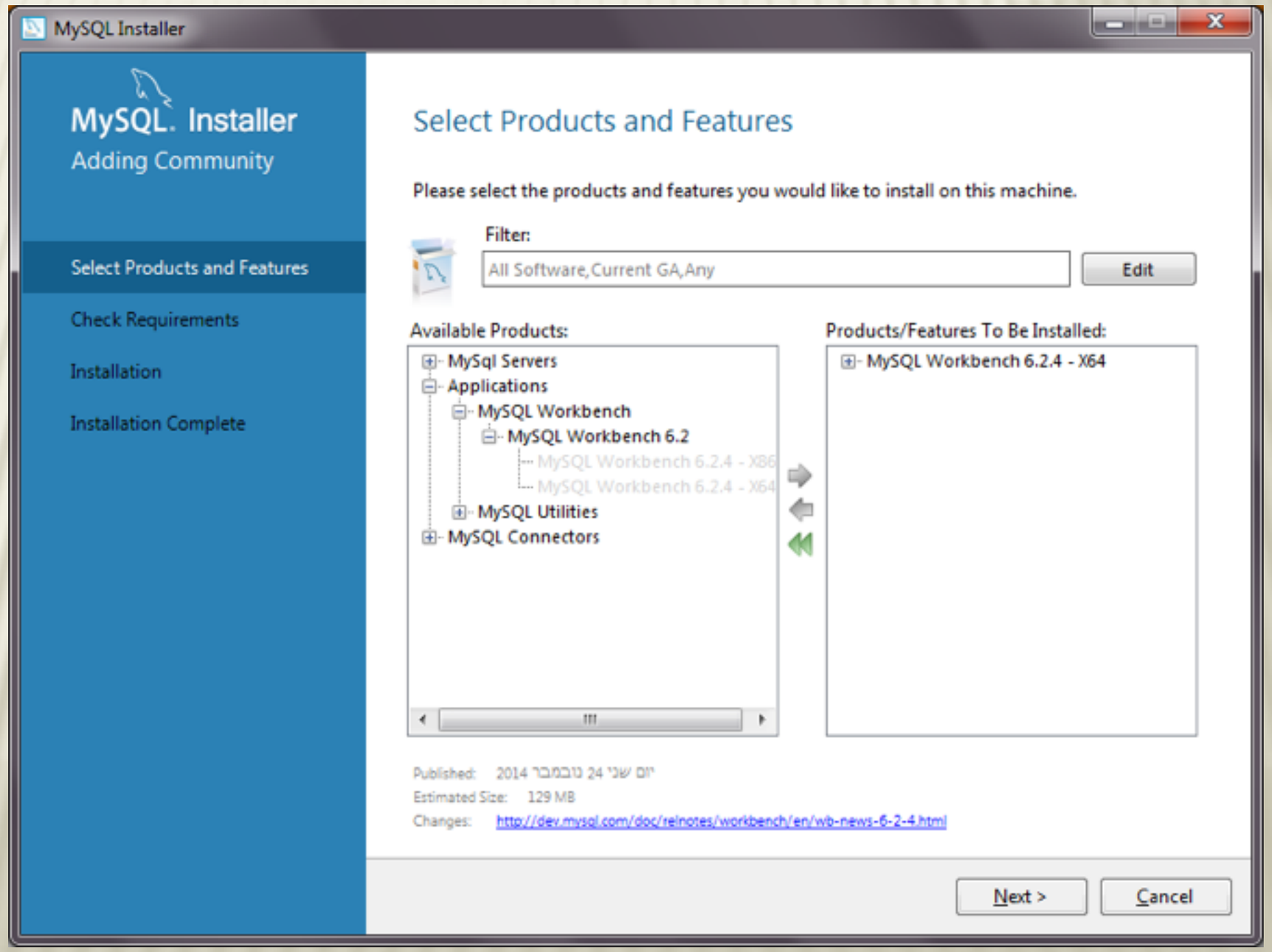


Installation using an Installer



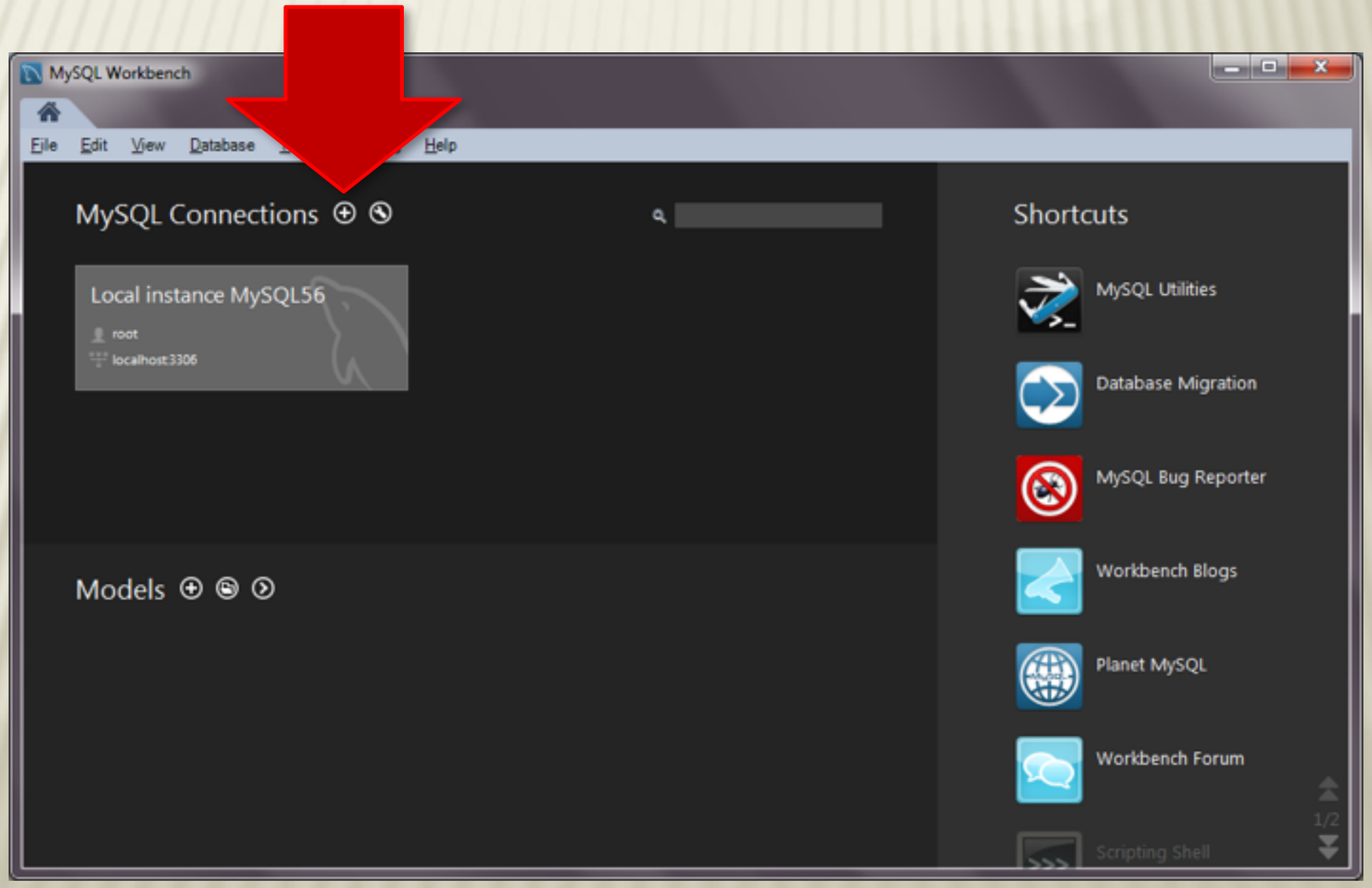
MySQL Workbench

- Make sure to install server, workbench and examples

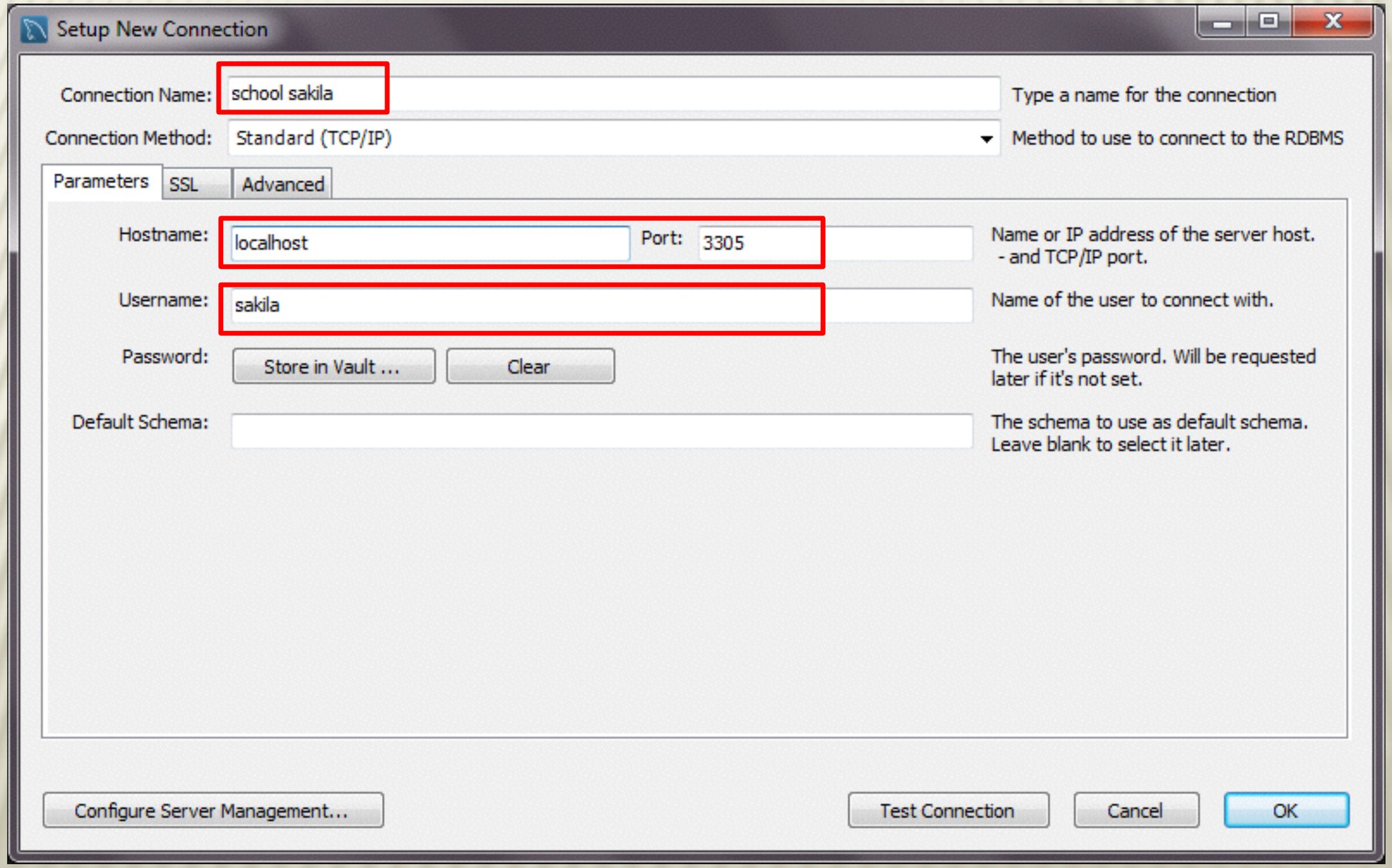


Example: connecting to school server

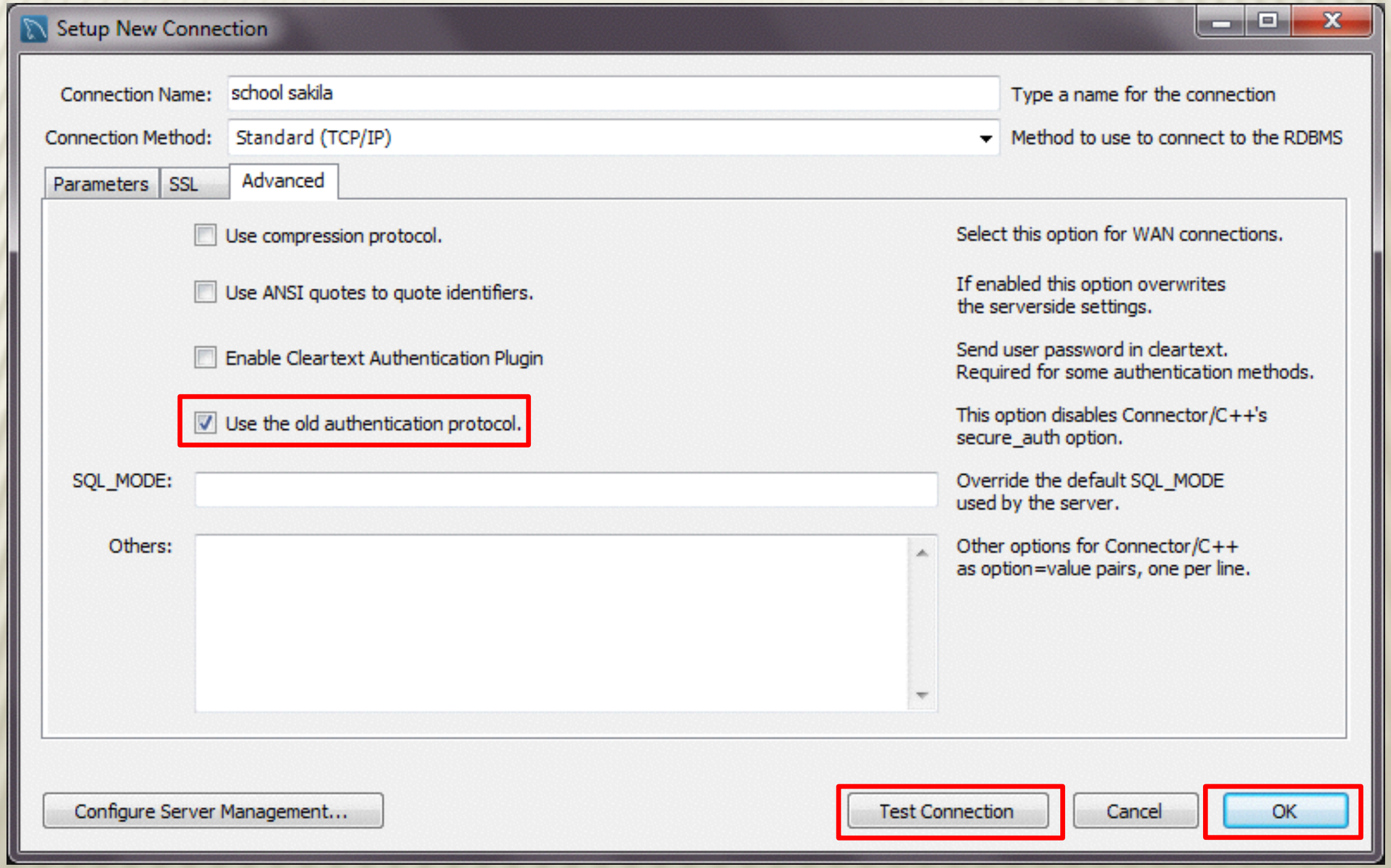
- Open the tunnel!
- Then open workbench and create new connection



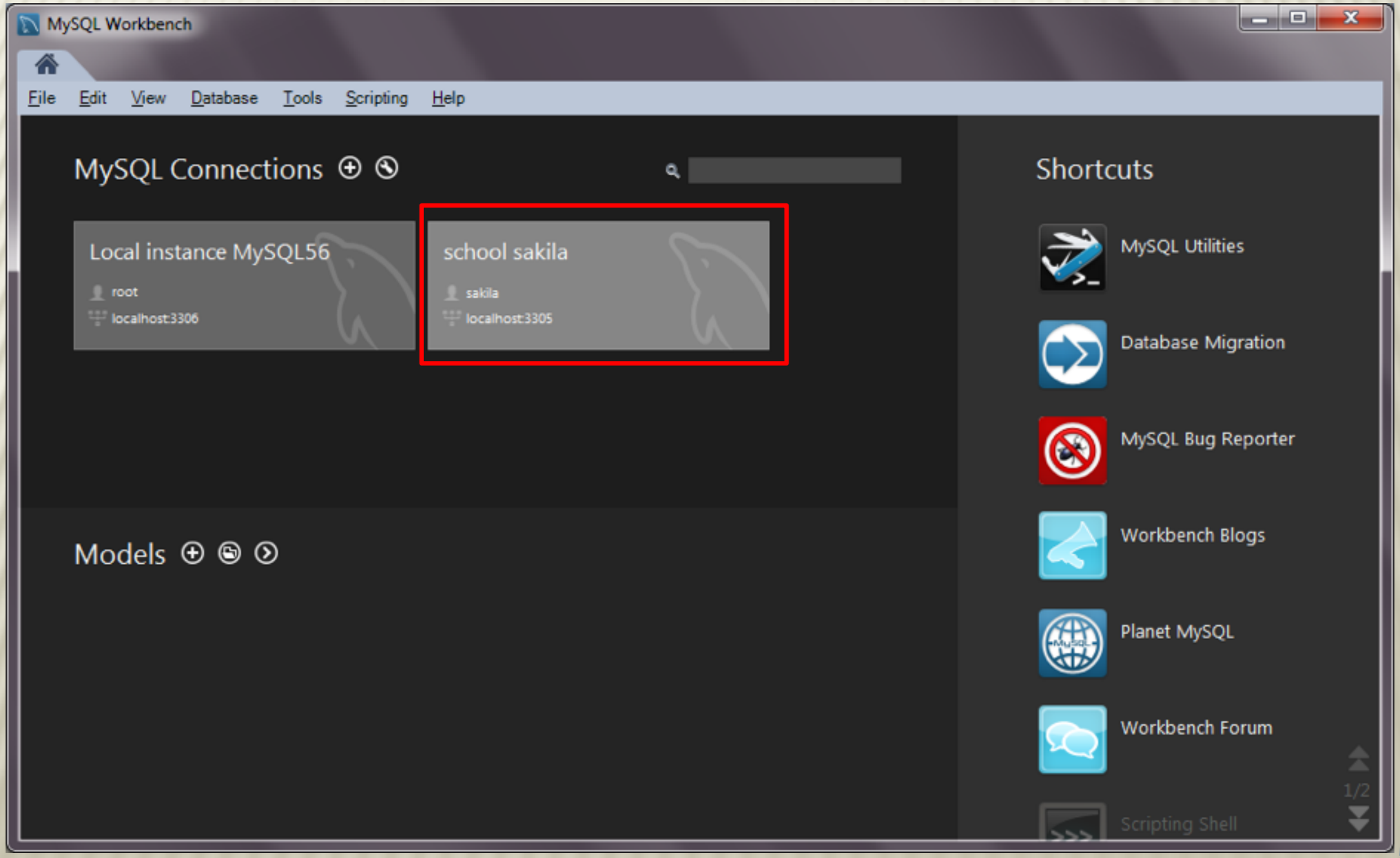
Configure the connection



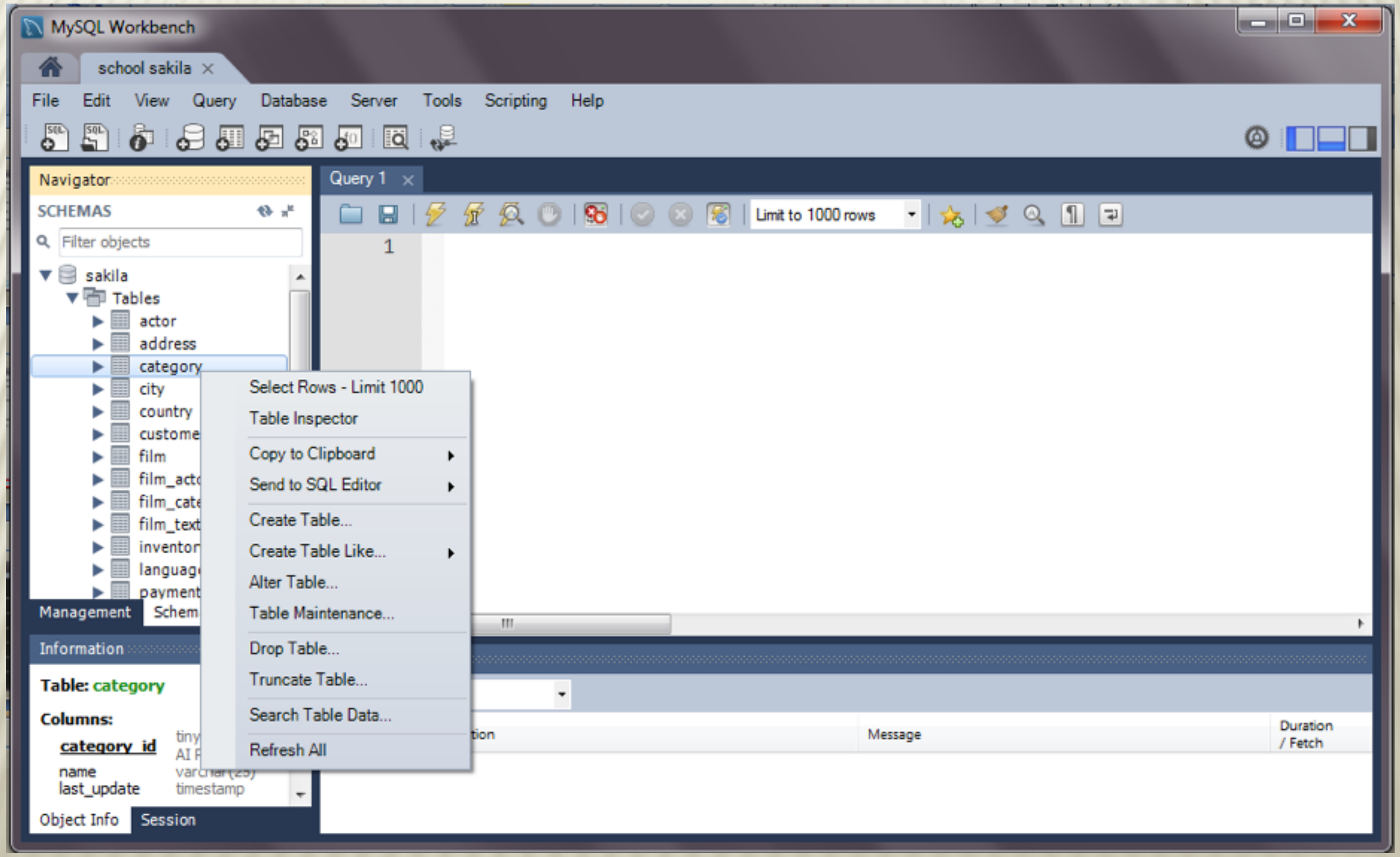
Support old authentication protocol



Open the new connection



Now you can query the SQL data



... and the result