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Centro Internazionale  
di Scienze Meccaniche  
*International Centre  
for Mechanical Sciences*

ISD  
Introduction  
to Spatial Database

CISM-UniUD Summer School  
coordinated by

Anna Frangipane  
University of Udine  
Italy



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# Introduction to (My)SQL

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# Outline

1. Database Management Systems
2. The Structured Query Language
3. Retrieving Data from a Database

All the material is available online:

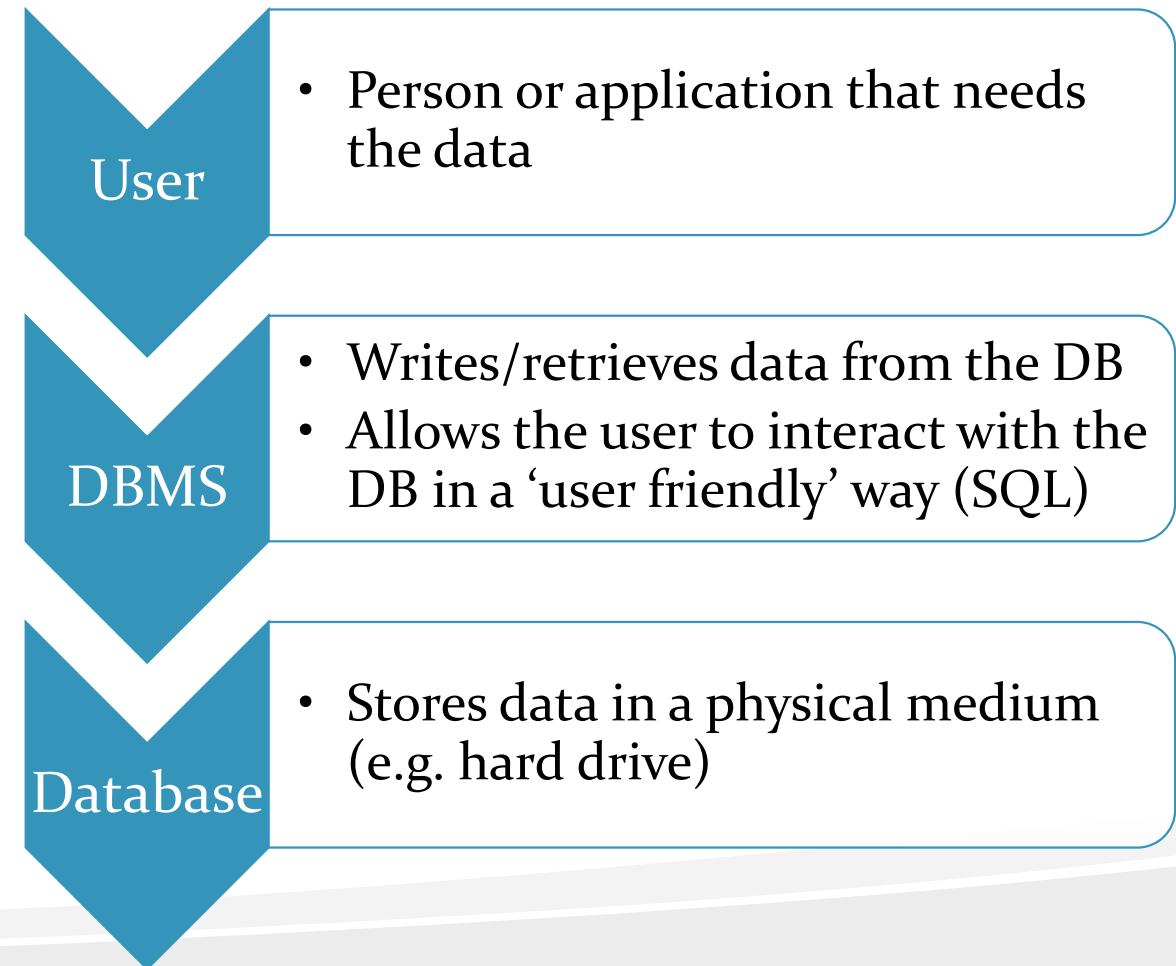
<https://github.com/basaldella/isd2018>



# Database Management Systems

# Database Management Systems

- **Database:** collection of data, tables, ...
- **DBMS:** software that allows the interaction and management of databases





# Database Management Systems/2

## Duties of a DMBS:

- Store the database **schema, data, tables...** efficiently
  - Data may be stored in a single file, or in dozens of computers
- Guarantee the **integrity** of the data
  - e.g.: prevent concurrency: users that write on the same table at the same moments
- Guarantee the **security** of the data
  - e.g.: prevent unauthorized operations: users that try to access data owned by other users



# Database Management Systems/3

Popular **relational** DBMSs:

- Oracle RDBMS (commercial)
- Microsoft SQL Server (commercial)
- PostgreSQL (Open Source Software)
- MySQL (OSS)

Other non-relational DBMSs: MongoDB, Redis, Zope...



- Free, open source relational database management system
- Paid version for enterprise customers
- “my”: name of the daughter of the founder
- Logo: Sakila the dolphin
- Founded in 1995, 2008 acquired by Sun Microsystems, 2010 acquired by Oracle
- MySQL users include **Facebook, Twitter, airbnb, Amazon, booking.com, NASA, Wordpress, Lufthansa...**



## MySQL/2

MySQL is composed by two parts:

- A **server**, which stores the data, and
- A **client**, which allows users and applications to run **SQL commands** on the server
- (human) Users can interact with the server with the **command-line client**, via **web clients**, or with specialized softwares



```
red@PICO-WINDOWS: ~  
red@PICO-WINDOWS:~$ mysql -u isd1 -p -h db.ailab.uniud.it  
Enter password:  
Welcome to the MySQL monitor.  Commands end with ; or \g.  
Your MySQL connection id is 10325  
Server version: 5.5.43-0ubuntu0.14.04.1 (Ubuntu)  
  
Copyright (c) 2000, 2018, Oracle and/or its affiliates. All rights reserved.  
  
Oracle is a registered trademark of Oracle Corporation and/or its  
affiliates. Other names may be trademarks of their respective  
owners.  
  
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.  
  
mysql> show databases;  
+-----+  
| Database |  
+-----+  
| information_schema |  
| isd1 |  
+-----+  
2 rows in set (0,04 sec)  
  
mysql> use isd1;  
Reading table information for completion of table and column names  
You can turn off this feature to get a quicker startup with -A  
  
Database changed  
mysql> show tables;  
+-----+  
| Tables_in_isd1 |  
+-----+  
| new_table |  
+-----+  
1 row in set (0,04 sec)  
  
mysql>
```

db.ailab.uniud.it / localhost | pl x +

db.ailab.uniud.it/phpmyadmin/index.php?

Cerca

phpMyAdmin

(Tabelle recenti) ...

information\_schema  
isd1  
Nuova  
new\_table

Database SQL Stato Esporta Importa Impostazioni Variabili Set di caratteri Motori

### Impostazioni Generali

[Cambia password](#)

Collation della connessione del server : utf8\_general\_ci

### Impostazioni di Presentazione

Lingua - Language : Italiano - Italian

Tema: pmahomme

Dimensione font: 82%

[Ulteriori impostazioni](#)

### Server del Database

- Server: Localhost via UNIX socket
- Tipo di server: MySQL
- Versione del server: 5.5.43-0ubuntu0.14.04.1 - (Ubuntu)
- Versione protocollo: 10
- Utente: isd1@localhost
- Codifica caratteri del server: UTF-8 Unicode (utf8)

### Web server

- Apache/2.4.7 (Ubuntu)
- Versione del client del database: libmysql - 5.5.43
- Estensioni PHP: mysqli

### phpMyAdmin

- Informazioni sulla versione: 4.0.10deb1
- Documentazione
- Wiki
- Home page ufficiale di phpMyAdmin
- Contribuisci
- Ricevi aiuto
- Lista dei cambiamenti

L'estensione [mcrypt](#) è mancante. Controlla la tua configurazione di PHP.



# Structured Query Language



# SQL

- Invented in the 1970s by IBM
- Standardized by ISO in 1987 (SQL-87)
  - Updated about every three years
  - Last standard: SQL:2016
- Each DBMS offers a *dialect* of SQL which works *roughly* the same
  - In practice, code is often **not** portable between different DBMSs



## SQL/2

We can see SQL as a family of *computer languages*:

- Data query language (DQL),
- Data definition language (DDL)
- Data control language (DCL)
- Data manipulation language (DML).

Note: different scholars group the languages differently, e.g. sometimes DQL is merged in DML.



# Data Control Language

Used to

- Create users, change passwords
  - `CREATE USER 'newuser' IDENTIFIED BY 'password';`
- Manage the privileges of the users in the database
  - e.g. allow user `john_smith` to access the table `foo`
  - e.g. prevent user `jane_doe` to modify the table `bar`
- We won't use DCL



# Data Query Language



# Data Query Language

Used to **query** the database, i.e. to **retrieve the data**

Example:

- retrieve the table 'foo':  
`SELECT * FROM foo`
- retrieve the user with username 'bar' from the table 'users':  
`SELECT * FROM users WHERE username = 'bar'`





# Data Query Language

Used to **query** the database, i.e. to **retrieve the data**

Examples:

- retrieve the table 'foo':  
`SELECT *`  
`FROM foo`
- retrieve the user with username 'bar' from the table 'users':  
`SELECT *`  
`FROM users`  
`WHERE username = 'bar'`



# Data Query Language: example

```
SELECT *  
FROM users  
WHERE username = 'bar'
```

WHERE restricts the selection to the rows that match the provided condition

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password
...	...	...
...	...	...

## Data Query Language: example/2

```
SELECT COUNT(*)  
FROM users  
WHERE password =  
'password'
```

COUNT counts the rows that match the condition provided by the WHERE clause

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password
...	...	...
...	...	...

```
red@PICO-WINDOWS: ~  
red@PICO-WINDOWS:~$ mysql -u isd1 -p -h db.ailab.uniud.it  
Enter password:  
Welcome to the MySQL monitor.  Commands end with ; or \g.  
Your MySQL connection id is 10449  
Server version: 5.5.43-0ubuntu0.14.04.1 (Ubuntu)  
  
Copyright (c) 2000, 2018, Oracle and/or its affiliates. All rights reserved.  
  
Oracle is a registered trademark of Oracle Corporation and/or its  
affiliates. Other names may be trademarks of their respective  
owners.  
  
Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.  
  
mysql> use isd1;  
Reading table information for completion of table and column names  
You can turn off this feature to get a quicker startup with -A  
  
Database changed  
mysql> SELECT COUNT( * )  
      -> FROM `users`  
      -> WHERE PASSWORD = 'password'  
      -> ;  
+-----+  
| COUNT( * ) |  
+-----+  
|          2 |  
+-----+  
1 row in set (0,04 sec)  
  
mysql>
```

```
red@PICO-WINDOWS: ~  
red@PICO-WINDOWS:~$ mysql -u isd1 -p -h db.ailab.uniud.it  
Enter password:  
Welcome to the MySQL monitor.  Commands end with ; or \g.  
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Copyright (c) 2000, 2018, Oracle and/or its affiliates. All rights reserved.  
  
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mysql> SELECT COUNT( * )  
      -> FROM `users`  
      -> WHERE PASSWORD = 'password'  
      -> ;  
+-----+  
| COUNT( * ) |  
+-----+  
|          2 |  
+-----+  
1 row in set (0,04 sec)  
  
mysql>
```

← query

← result

← execution time



# Data Query Language/concl.

SELECT can be combined with **lots** of commands:

- MIN, MAX, SUM, return the minimum, maximum, or the sum of the values for a given column
- ORDER\_BY orders the results based on one or more attributes
- GROUP\_BY groups the results based on one or more attributes
- DISTINCT returns only different values



# Examples

WHERE

```
SELECT *  
FROM Students  
WHERE Password =  
'password'
```

Returns

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password



# Operators

Operator	Meaning	Example
=	Equals	name = 'john'
!=	Not equals	name != 'john'
>	Greater than	age > 17
>=	Greater or equal than	age >= 18
<	Less than	price < 10
<=	Less or equal than	Price <= 100
AND, OR, NOT	Logical and, or, not	price > 1 AND price < 10





# Examples

## Multiple operators

```
SELECT *  
FROM Students  
WHERE Password =  
'password' AND Id > 3
```

## Returns

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password



# Examples

MIN, MAX, SUM, AVG

```
SELECT MAX(ID)  
FROM Students
```

Returns

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password



# Examples

## ORDER BY

```
SELECT *  
FROM Students  
ORDER BY username
```

Reverse order:

```
ORDER BY field ASC
```

## Returns

ID	username	Password
5	anne.other	password
2	bar	password
1	foo	12345
4	jane.doe	isd2018
3	john.smith	99999



# GROUP BY

## How it works

- Combined with aggregate function (min, max ... )
- **Groups** the result set by one or more columns
- **Example:**  
How many people by Country?

## Example table

ID	Name	Country
1	Mario Rossi	Italy
2	Max Mustermann	Germany
3	Rosa Bianchi	Italy
4	Giuseppe Verdi	Italy
5	John Smith	U.K.
6	Pierre Toulemonde	France
7	Anne Other	U.K.
8	Jane Doe	U.K.



# GROUP BY

## How it works

```
SELECT Country, Count(ID)  
FROM Students  
GROUP BY Country
```

## Returns

Country	COUNT(ID)
Italy	3
Germany	1
U.K.	3
France	1



# GROUP BY

## How it works

```
SELECT Country, Count(ID)
FROM Students
GROUP BY Country
ORDER BY Count(ID) ASC
```

## Returns

Country	COUNT(ID)
France	1
Germany	1
U.K.	3
Italy	3



# Examples

DISTINCT

```
SELECT  
DISTINCT(Password)  
FROM Students
```

Returns

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password

# Nested Queries

Suppose we want to find the users who are banned.

Table **Banned\_Users**:

ID
2
5

Table **Users**:

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password



# Nested Queries

Suppose we want to find the users who are banned.

Instruction **IN**:

```
SELECT *  
FROM Users  
WHERE ID IN (2,5)
```

Table **Banned\_Users**:

ID
2
5

Table **Users**:

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password

# Nested Queries

Even better: we can “nest” queries

```
SELECT *  
FROM Users  
WHERE ID IN (  
    SELECT ID  
    FROM Banned_Users  
);
```

Table **Banned\_Users**:

ID
2
5

Table **Users**:

ID	username	Password
1	foo	12345
2	bar	password
3	john.smith	99999
4	jane.doe	isd2018
5	anne.other	password



# MySQL Workbench

Hands-on tutorial



# MySQL Workbench

MySQL Workbench is a software that offers a graphical user interface (GUI) to easily manage of MySQL servers. It offers

- Database diagrams (EER)
- Database visualization
- SQL console
- Performance monitoring
- ...

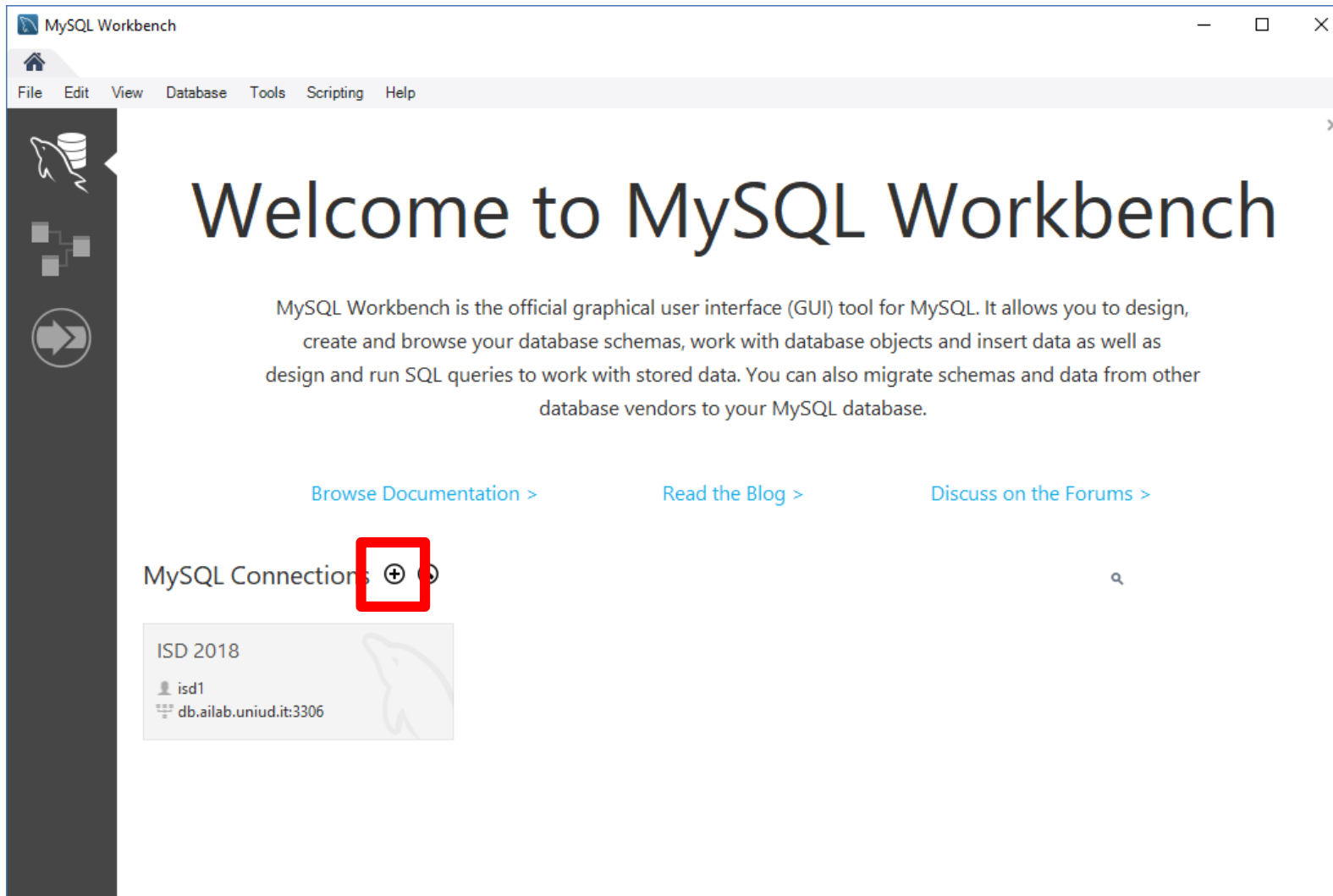


## MySQL Workbench/2

We will use MySQL Workbench as our tool of choice for working with MySQL.

You will work with a database installed in the Artificial Intelligence Laboratory servers. The credentials are:

- hostname: `db.ailab.uniud.it`
- username: `isdXX`, where XX is the number of your PC
- password: `ISD2018`



Step 1: click on the + (“plus”) icon near to “MySQL Connections”

Setup New Connection

Connection Name:  Type a name for the connection

Connection Method:  Method to use to connect to the RDBMS

Parameters SSL Advanced

Hostname:  Port:  Name or IP address of the server host - and TCP/IP port.

Username:  Name of the user to connect with.

Password:   The user's password. Will be requested later if it's not set.

Default Schema:  The schema to use as default schema. Leave blank to select it later.

Step 2: insert the credentials (fields “Connection Name, Hostname, Username”)

**Setup New Connection**

Connection Name:  Type a name for the connection

Connection Method:  Method to use to connect to the RDBMS

Parameters SSL Advanced

Hostname:  Port:  Name or IP address of the server host - and TCP/IP port.

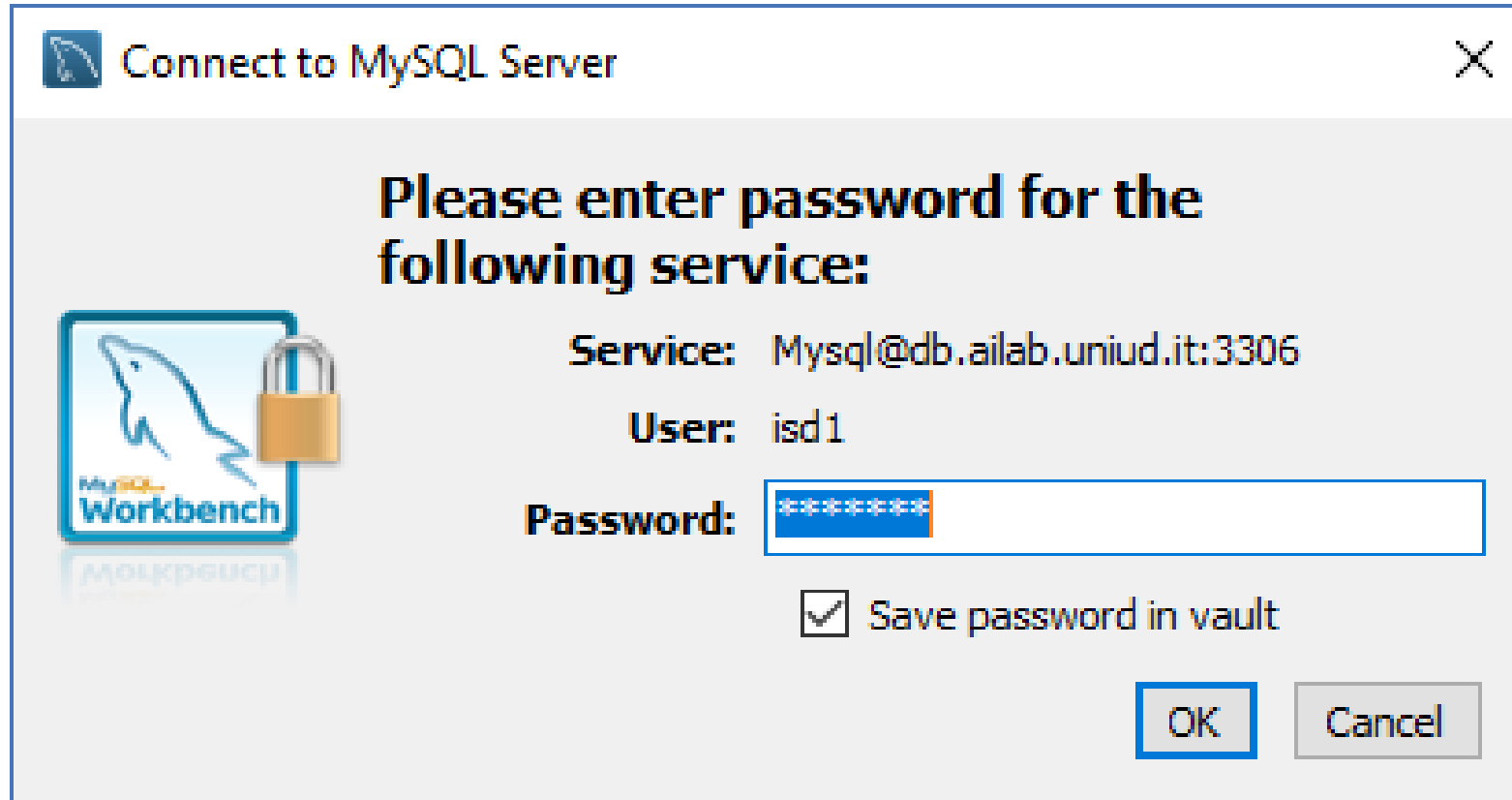
Username:  Name of the user to connect with.

Password:   The user's password. Will be requested later if it's not set.

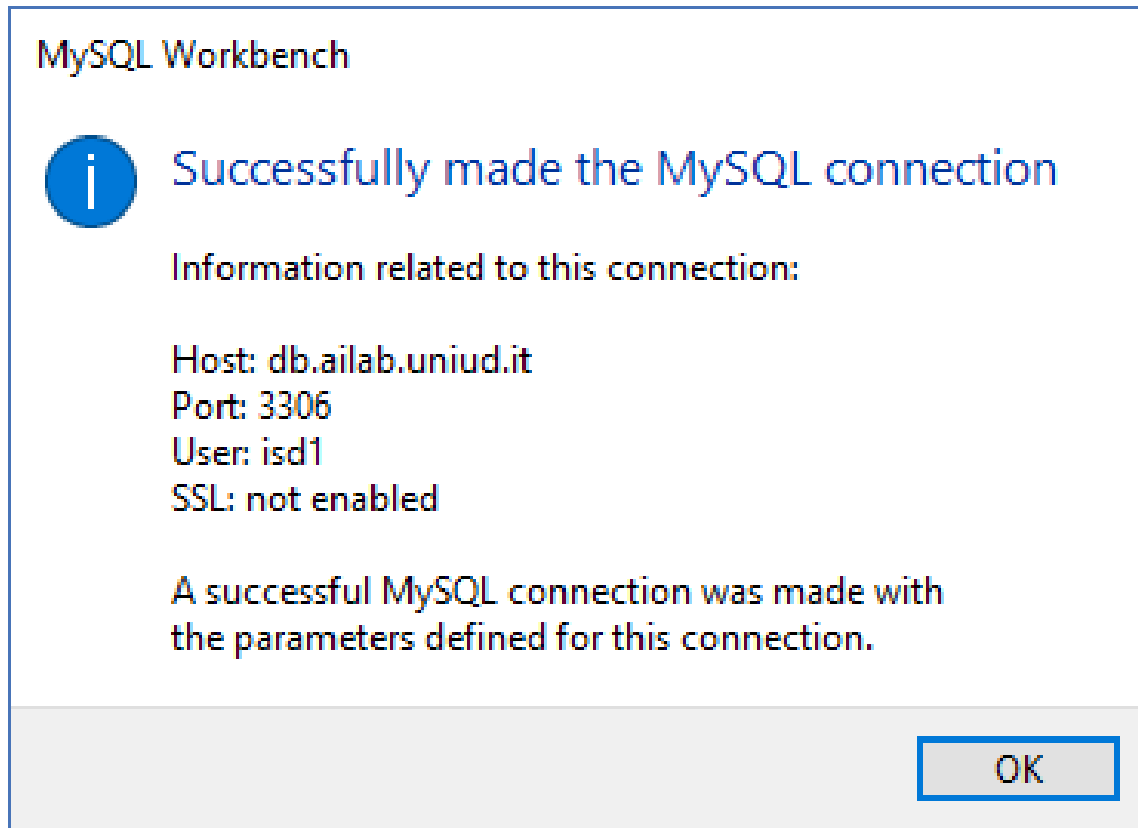
Default Schema:  The schema to use as default schema. Leave blank to select it later.

Step 3: click on “Test Connection”





Step 4: Insert the password (look at the blackboard!)



You should see **exactly** this window

If this window **doesn't show up** call me, I'll come and help you

# Welcome to MySQL Workbench

MySQL Workbench is the official graphical user interface (GUI) tool for MySQL. It allows you to design, create and browse your database schemas, work with database objects and insert data as well as design and run SQL queries to work with stored data. You can also migrate schemas and data from other database vendors to your MySQL database.

[Browse Documentation >](#)


[Read the Blog >](#)

[Discuss on the Forums >](#)

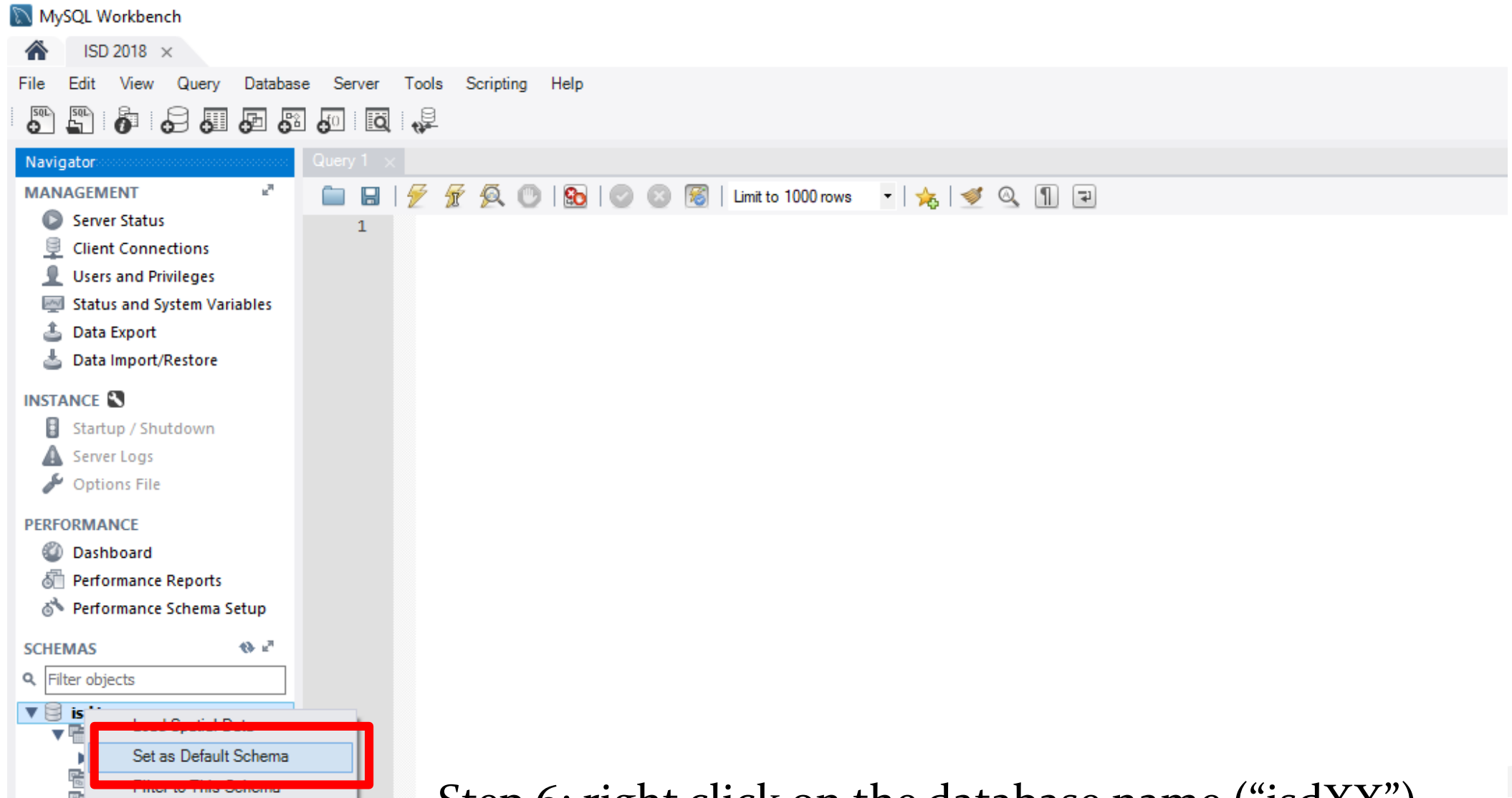
MySQL Connections  

ISD 2018

 isd1

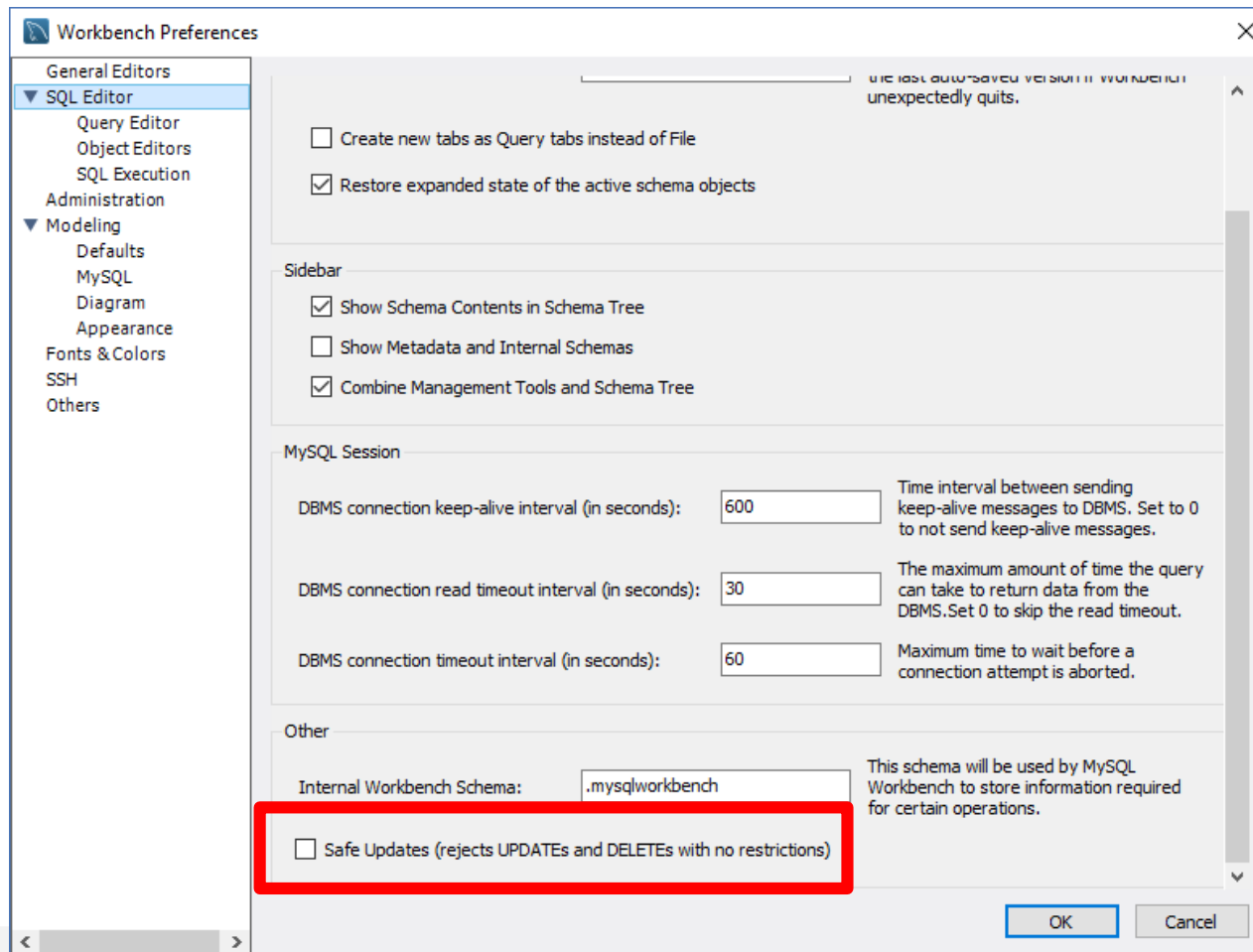
 db.aialab.uniud.it:3306

Step 5: double click on the newly created connection



Step 6: right click on the database name (“isdXX”), select “Set as Default Schema”

# Disable safe mode



- Click on “Edit → Preferences”
- Click on “SQL Editor” in the left panel
- Scroll down and disable “Safe Updates”

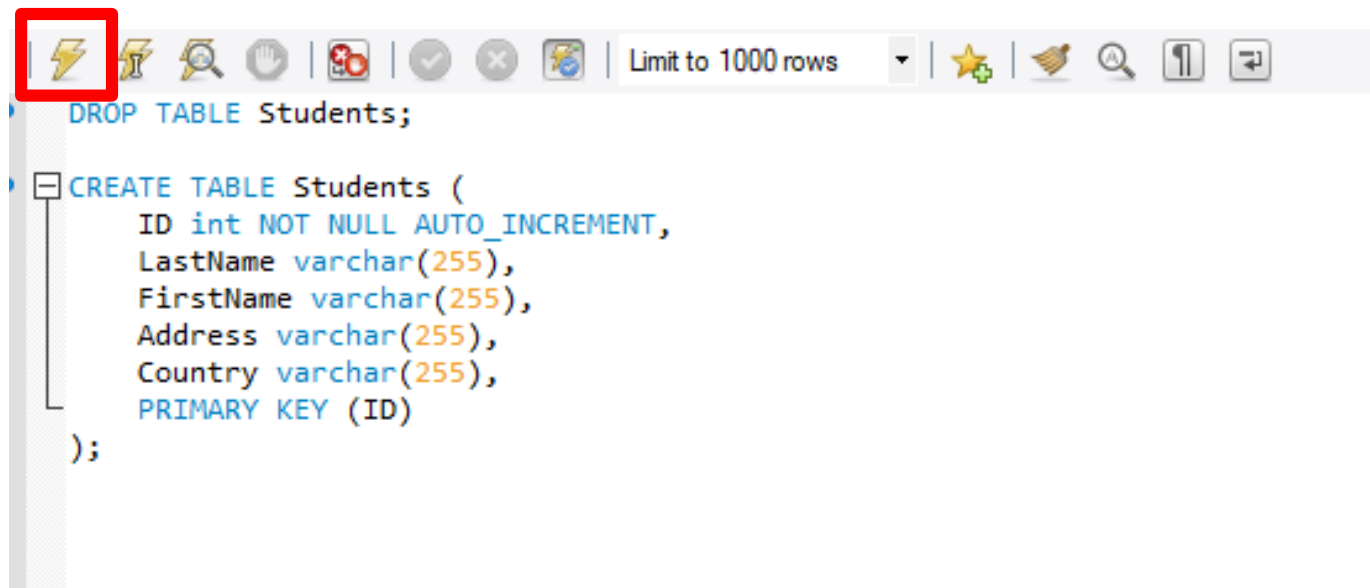


## Our first table

```
CREATE TABLE Students (  
    ID int NOT NULL AUTO_INCREMENT,  
    LastName varchar(255),  
    FirstName varchar(255),  
    Address varchar(255),  
    Country varchar(255),  
    PRIMARY KEY (ID)  
);
```

## Our first table/2

- Copy/paste the code into the text area
- Click on the lightning icon to run it

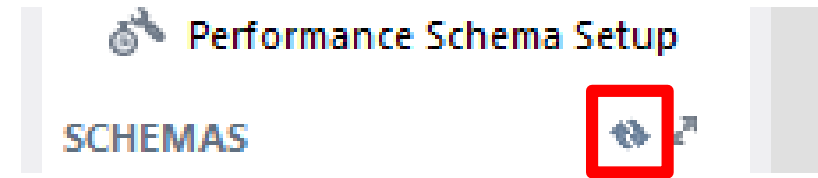


The screenshot shows a SQL IDE interface. At the top, there is a toolbar with various icons. A red box highlights the lightning bolt icon, which is used to execute the SQL code. Below the toolbar, the code editor displays the following SQL statement:

```
DROP TABLE Students;  
  
CREATE TABLE Students (  
    ID int NOT NULL AUTO_INCREMENT,  
    LastName varchar(255),  
    FirstName varchar(255),  
    Address varchar(255),  
    Country varchar(255),  
    PRIMARY KEY (ID)  
);
```

## Our first table/3

- Click on the refresh icon near “Schemas”: the table should appear

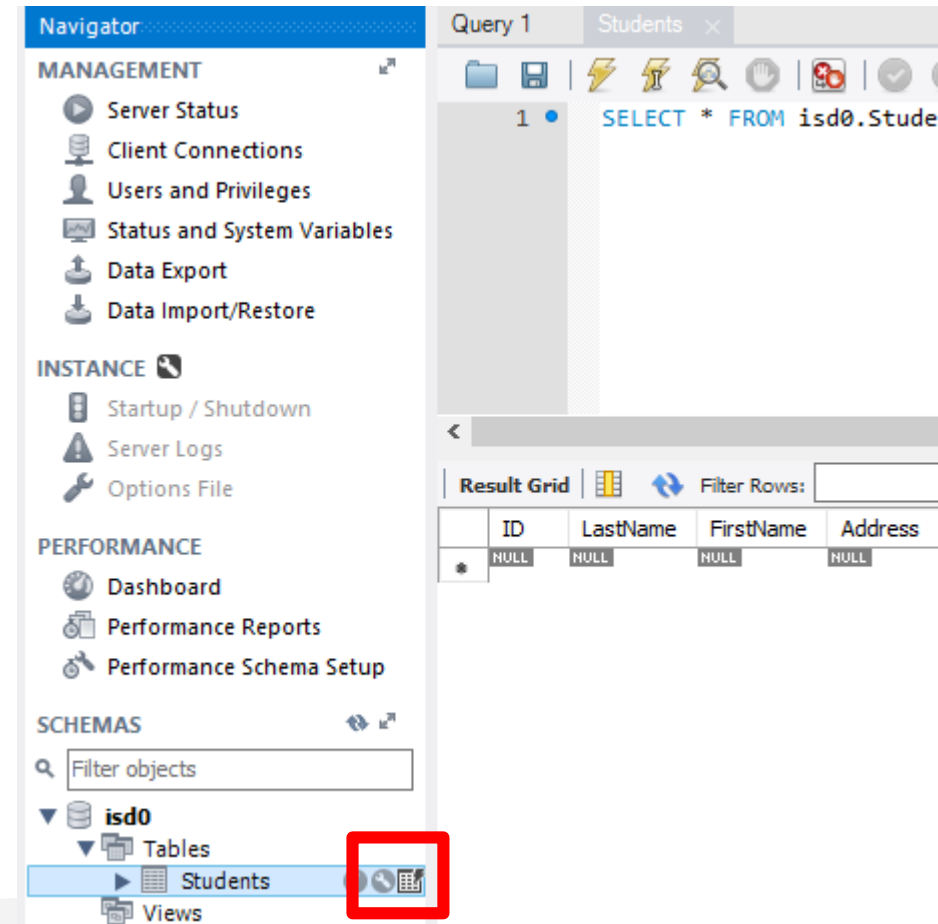




# Our first table/4

To see the table:

- Open “isdXX”
- Open “tables”
- Click on the table icon with the small lightning; this will automatically show all the contents of the table.



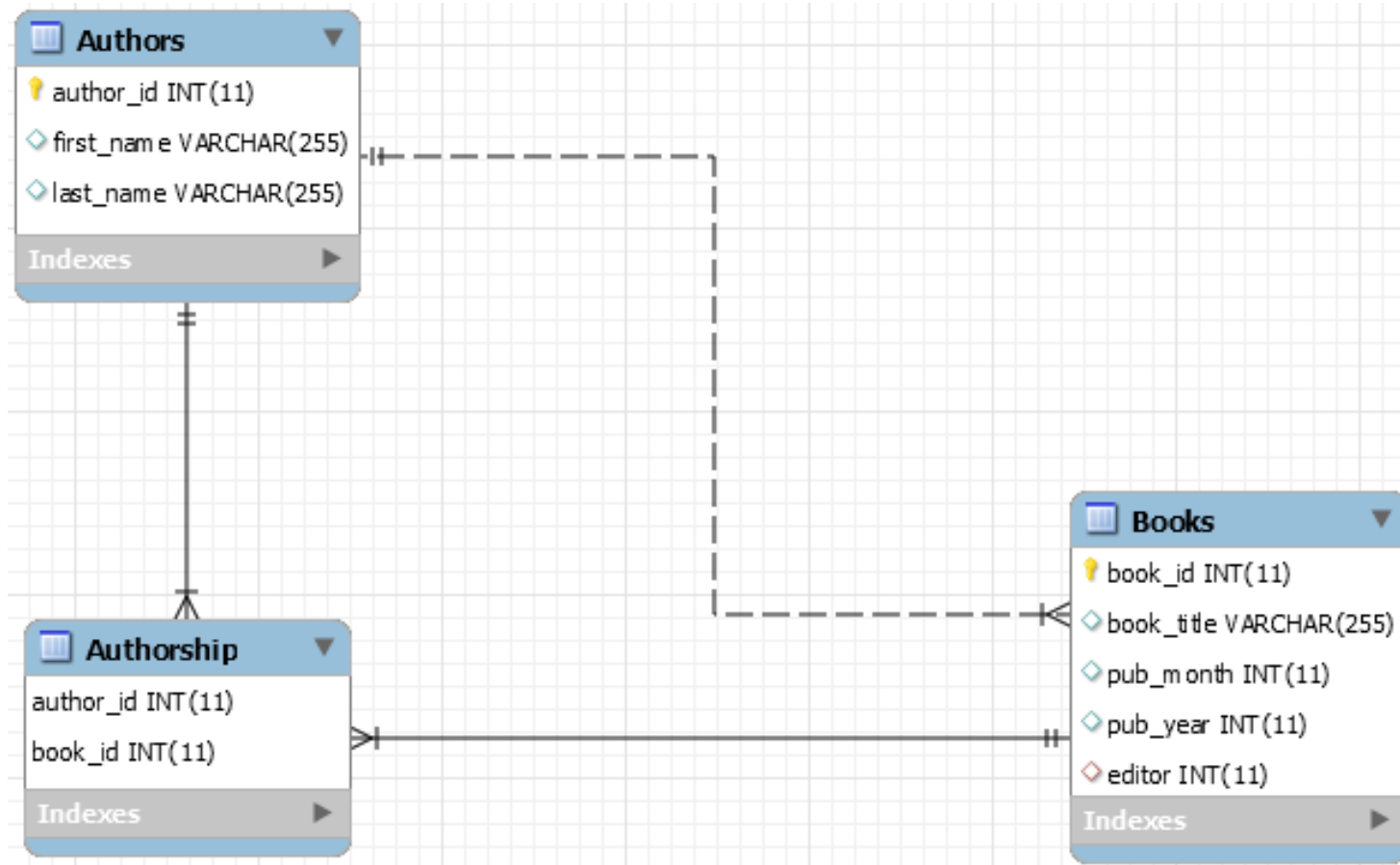


# Hands-on exercises

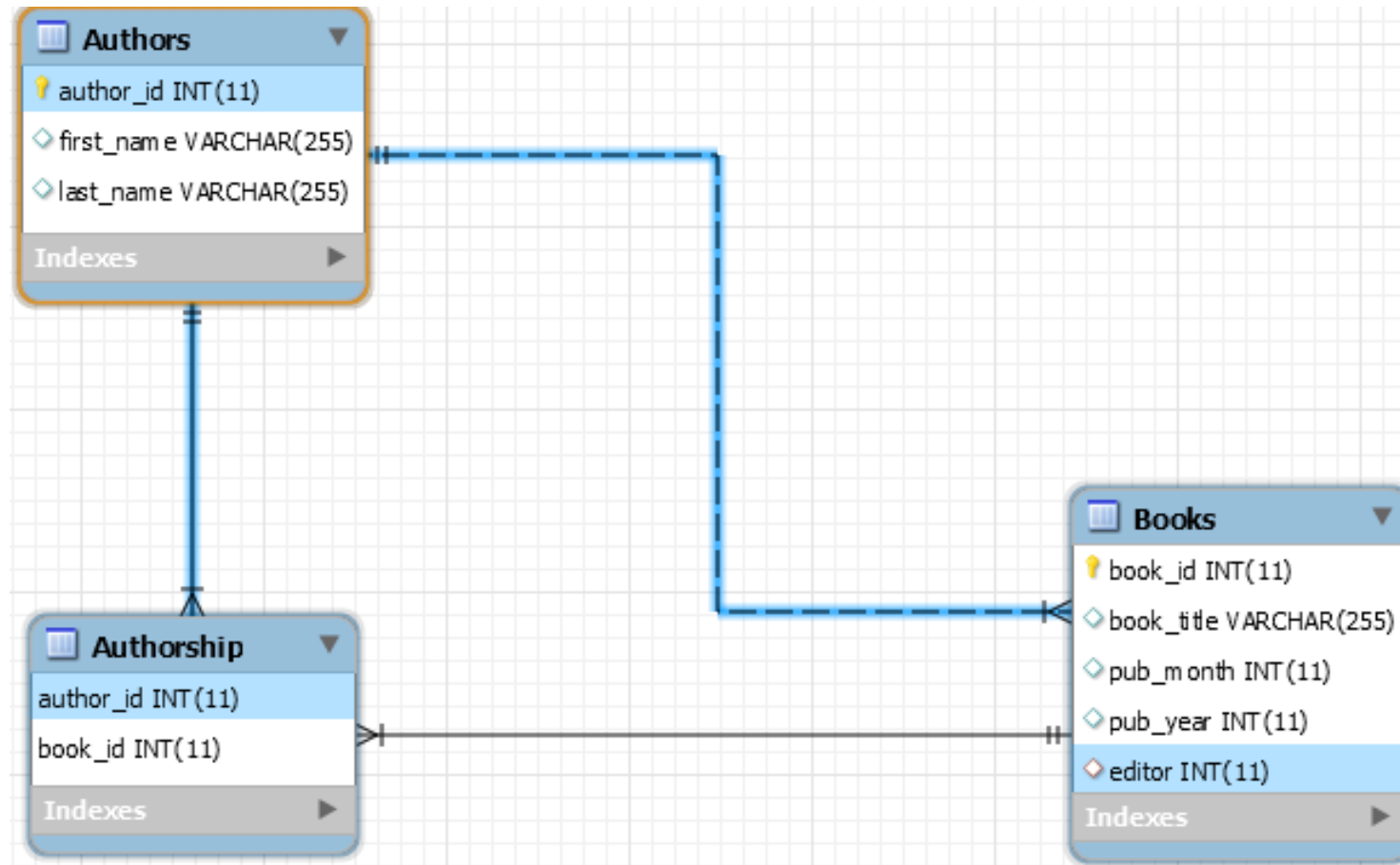


## Example: a book database

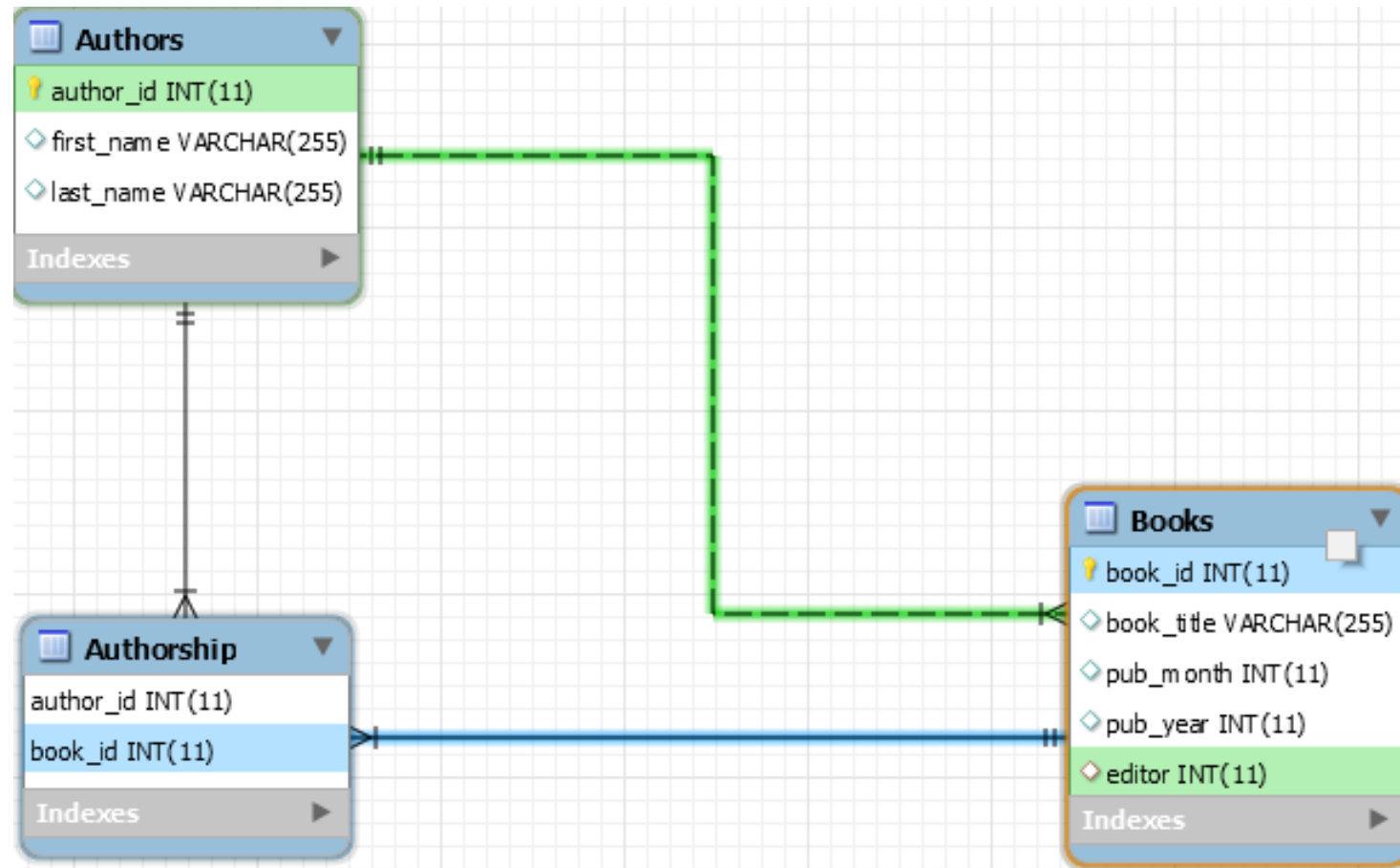
- We have to keep track of the records for a library.
- A book is identified by an ID, and its attributes are the title, the publication month and year, and its editor.
- A book can have more than one author.
- A book must have exactly one editor.
- An author/editor is identified by an ID, and its attributes are her/his name and surname.



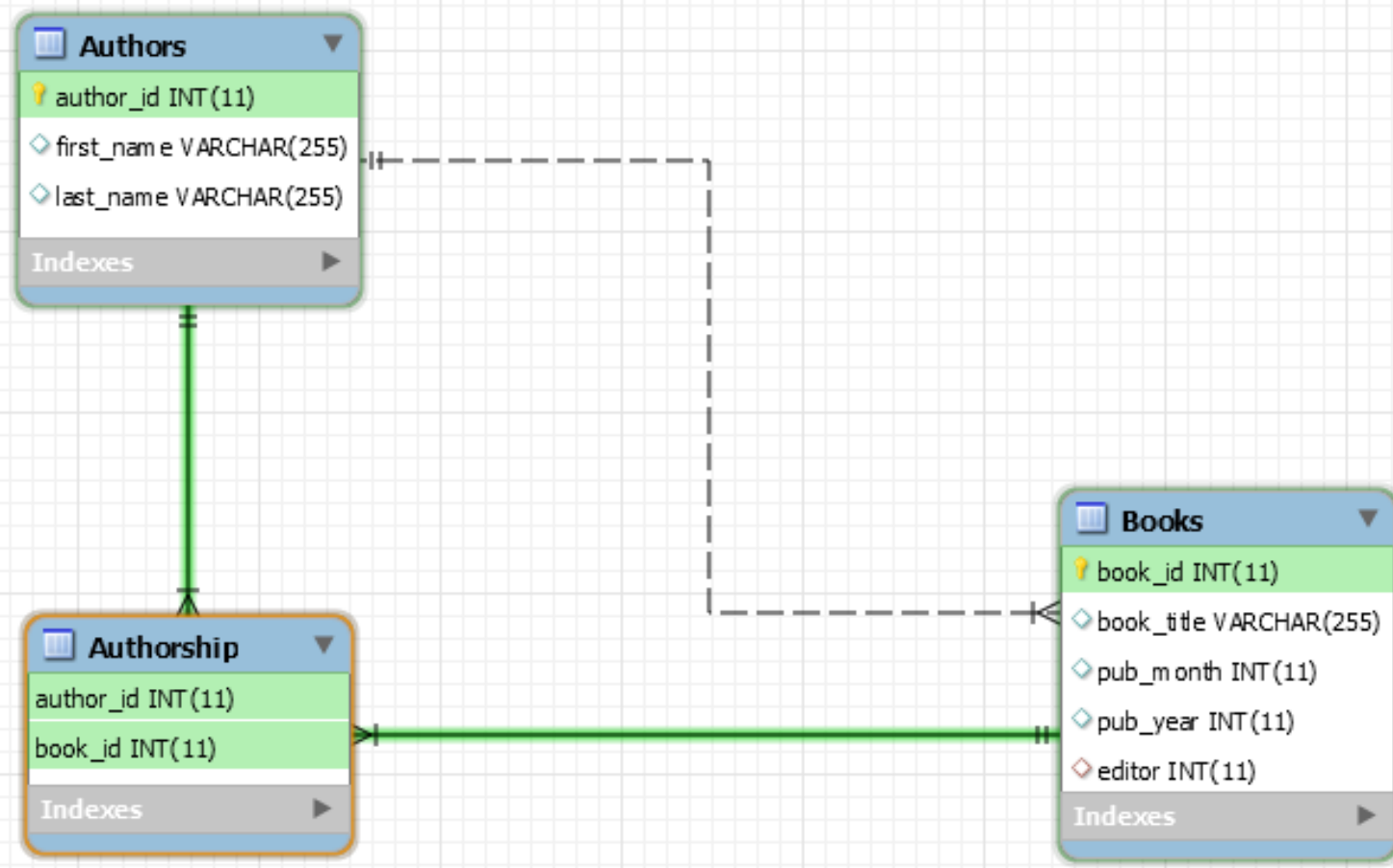
## Tables: Authors, Books, Authorship



`author_id`: key for **Authors**  
Referenced by `Authorship.editor` and by `Books.editor`



`book_id`: key for **Books**  
Referenced by `Authorship.book_id`



**Authorship:** the key is the couple `author_id`, `book_id`



## Create the toy database

- Draw the ER diagram (optional).
- Download the code for the second day from **<https://github.com/basaldella/isd2018>** and run it.
- Now you should have the three tables populated with some data: view it by running

```
SELECT * FROM Books
```

Repeat the selection for the other two tables.





## Exercises: 2

1. View the content of all the tables (`SELECT * ...`)
2. Find all the books published in 1956.
3. Find the titles of the books edited by Dimitri Kent.
4. Sort the books by publication year.
5. Find the surnames of the authors who wrote at least a book.
6. Sort in descending order the authors by number of books authored and edited.



## Exercises: hard

7. Find the authors who did not publish or author a book.
8. Find the authors who are publishers and editors.