

DATABASES – PRACTICAL COURSE PREPARATION

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Intro

Virtualisation
&
Docker

DataGrip
IDE

Sample
Data

INTRO

A FEW WORDS TO BEGIN WITH

What is it all about?

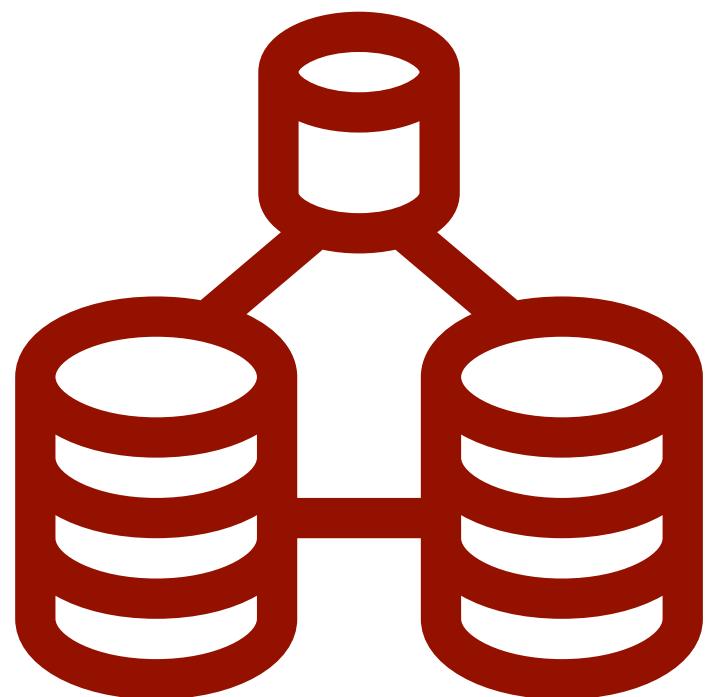
Of course, for the lectures and exercises we will need a real database, or more precisely, a "**database management system (DBMS)**".

This will be used to **illustrate the concepts** and also to provide the data for the SQL lab and our applications.

This short tutorial will show you how to

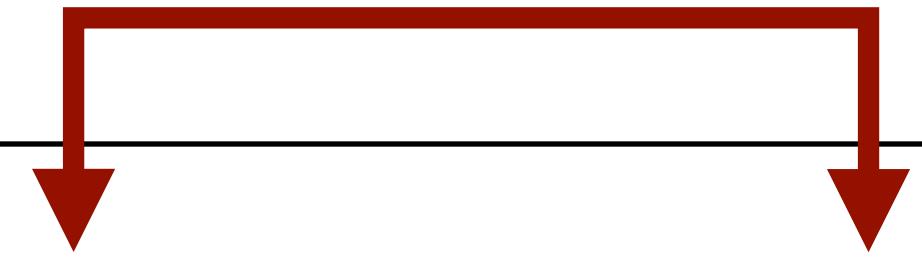
- **set this up and**
- **import the necessary data**

so that we can work with it in the lab.



A first example

A common type of DBMS is called a **relational** DBMS (RDBMS). Here, data is organised in **tables** that have a relationship to each other - hence "relational".



id	product	category	price
4	Fish Fingers	1	1.99
5	Pasta Pan	1	3.29
6	Carrots	2	0.39
7	Onions	2	0.29
8	Bananas	2	1.29
9	Garlic	2	0.98
10	Pork Sausage	3	1.99
11	Meatballs	3	2.35
12	Milk	4	0.79
13	Quark	4	0.99
14	Yoghurt	4	0.98
15	Cola light	5	1.50

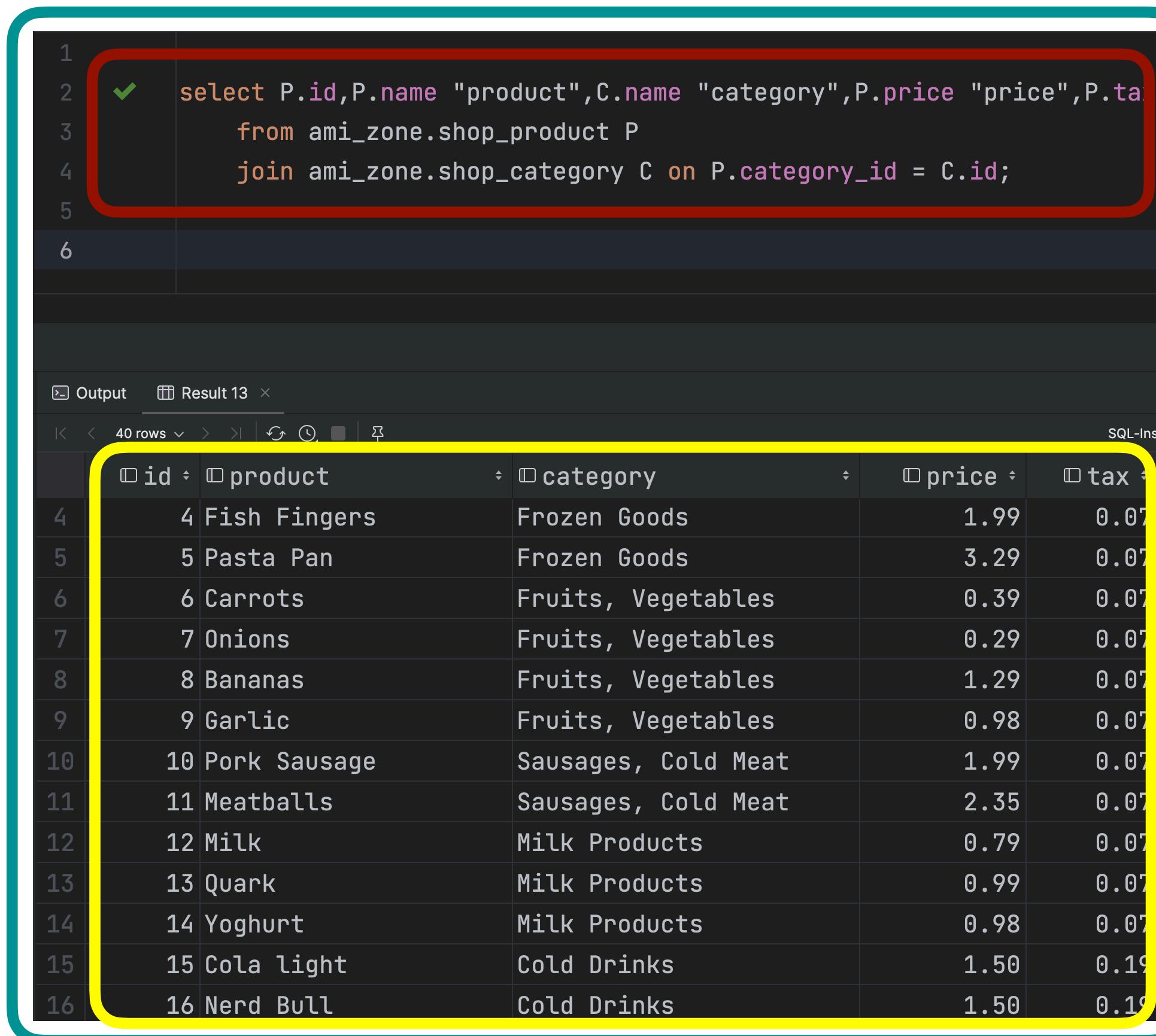
category	name
1	Frozen Goods
2	Fruits, Vegetables
3	Sausages, Cold Meat
4	Milk Products
5	Cold Drinks
6	Barbecue Products
7	Snacks
8	Hot Drinks
9	Convenience Foods
10	Baked Goods
11	Magazines
12	Services

Related product data from the `ami_zone` database

Although there are other systems with different organisational structures, this structured view of the data is sufficient to get you started.

We need...

a language in
which to talk to
the database.



A screenshot of a SQL interface showing a query and its results. The query is:

```
1
2 ✓ select P.id,P.name "product",C.name "category",P.price "price",P.tax
  from ami_zone.shop_product P
  join ami_zone.shop_category C on P.category_id = C.id;
```

The results table has columns: id, product, category, price, tax. The data is:

	id	product	category	price	tax
4	4	Fish Fingers	Frozen Goods	1.99	0.07
5	5	Pasta Pan	Frozen Goods	3.29	0.07
6	6	Carrots	Fruits, Vegetables	0.39	0.07
7	7	Onions	Fruits, Vegetables	0.29	0.07
8	8	Bananas	Fruits, Vegetables	1.29	0.07
9	9	Garlic	Fruits, Vegetables	0.98	0.07
10	10	Pork Sausage	Sausages, Cold Meat	1.99	0.07
11	11	Meatballs	Sausages, Cold Meat	2.35	0.07
12	12	Milk	Milk Products	0.79	0.07
13	13	Quark	Milk Products	0.99	0.07
14	14	Yoghurt	Milk Products	0.98	0.07
15	15	Cola light	Cold Drinks	1.50	0.19
16	16	Nerd Bull	Cold Drinks	1.50	0.19

a program for handling
commands, results and
the database itself.

a database
that provides
the data.

We teach SQL, ...

a language in
which to talk to
the database.

```
1  ✓  select P.id,P.name "product",C.name "category",P.price "price",P.ta.  
2      from ami_zone.shop_product P  
3      join ami_zone.shop_category C on P.category_id = C.id;  
4  
5
```

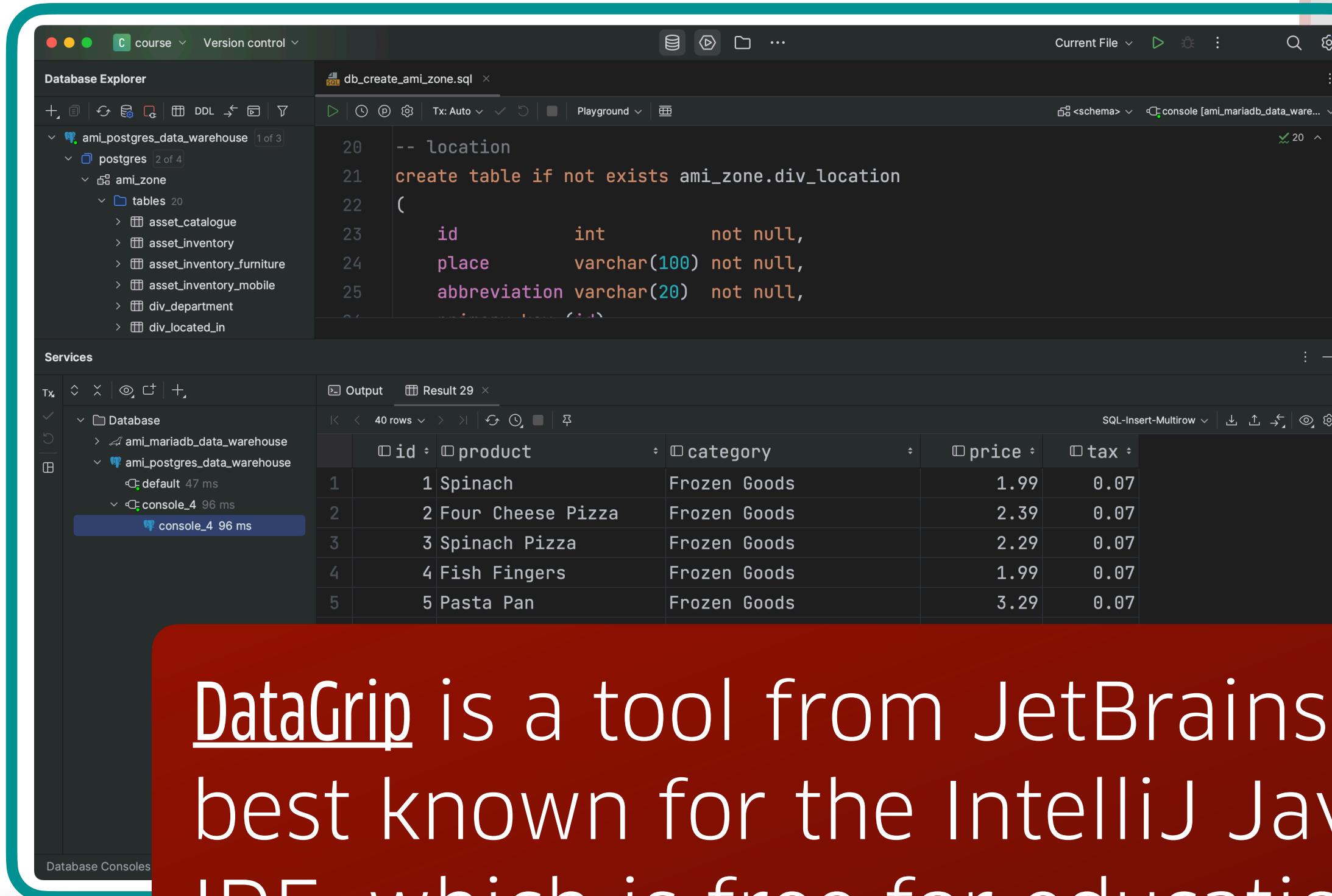


a program for handling
commands, results and
the database itself.

The database language SQL is
a major component of the
exercises.

a database
that provides
the data.

We suggest DataGrip, ...



DataGrip is a tool from JetBrains, best known for the IntelliJ Java IDE, which is free for educational purposes. In principle, however, you can use **any other tool** or IDE that suits your DBMS.

a language in
which to talk to
the database.

a program for handling
commands, results and
the database itself.

a database
that provides
the data.

We work with MariaDB, ...

There are many DBMS, including free ones. We recommend

- PostgreSQL but also
- MariaDB.

Both are good for our purposes.

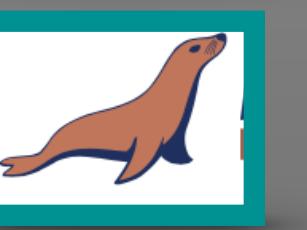
6 Carrots	Fruits, Vegetables	0.39	0.07
7 Onions	Fruits, Vegetables	0.29	0.07
8 Bananas	Fruits, Vegetables	1.29	0.07
9 Garlic	Fruits, Vegetables	0.98	0.07
10 Pork Sausage	Sausages, Cold Meat	1.99	0.07
11 Meatballs	Sausages, Cold Meat	2.35	0.07
12 Milk	Milk Products	0.79	0.07
13 Quark	Milk Products	0.99	0.07
14 Yoghurt	Milk Products	0.98	0.07
15 Cola light	Cold Drinks	1.50	0.19
16 Nerd_Bull	Cold Drinks	1.50	0.19

a language in which to talk to the database.

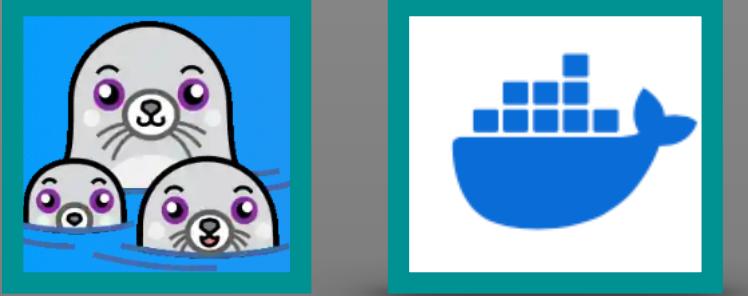
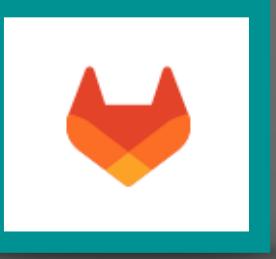
a program for handling commands, results and the database itself.

a database that provides the data.

Some Remarks on the DBMS

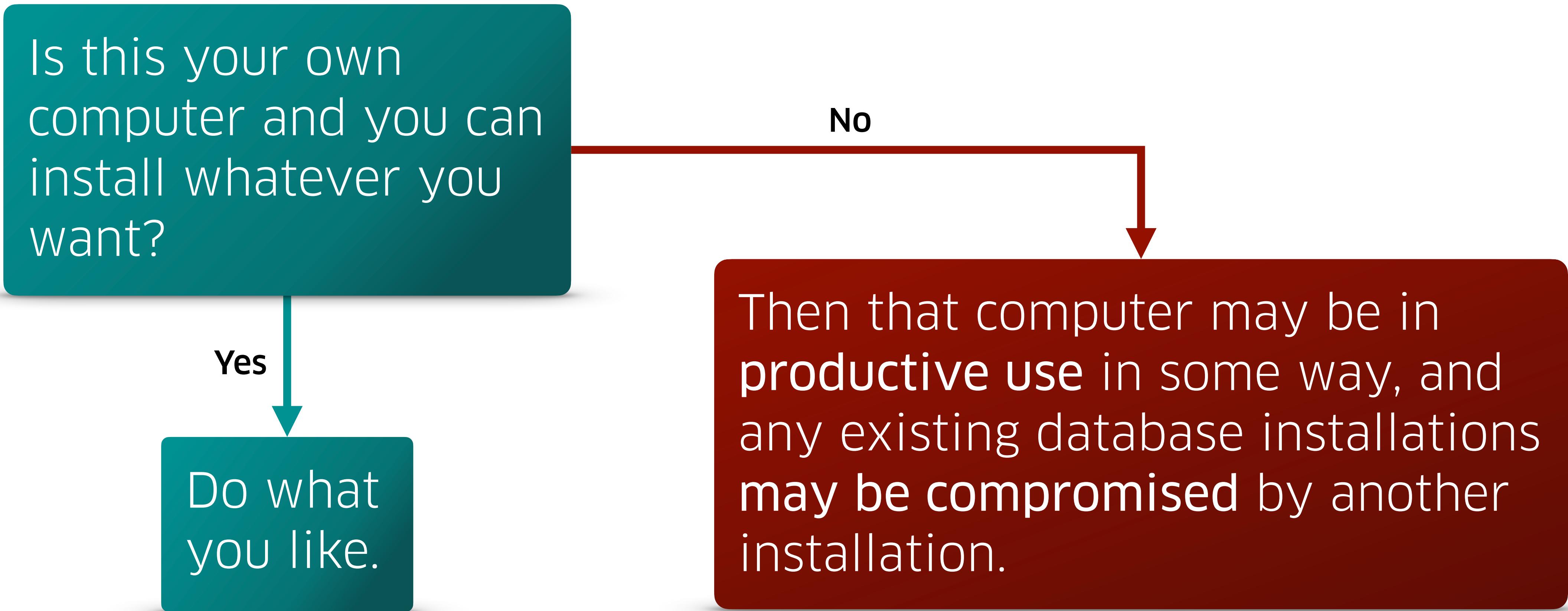
- The first thing to say is that although we are mainly working with a specific relational DBMS (PostgreSQL), the **concepts** presented in the Databases module are transferable to other relational DBMSs as well as to so-called non-relational, e.g. NoSQL, databases.
- PostgreSQL is widely regarded as the most standards-compliant and compatible open-source RDBMS, especially when it comes to SQL:2011/2016. 
- MariaDB would be an alternative, but we have now decided on PostgreSQL. 
- Note that the the **SQL dialects** of each DBMS are different. Although the general structure of an SQL command can often be transferred to another DBMS, details such as quotation marks or upper and lower case may behave differently. If you want to use the material with another DBMS, you may need to make small adjustments.
- Unfortunately, it is not possible to maintain the resources for all popular DBMS.

What is to come

- The next step is to install **your own DBMS** while avoiding side effects on your own computer. We do this by using **virtualisation**.
- We use [Podman](#) or [Docker](#) for virtualization (with their respective UIs). You probably already have one installed – if not, please install one.
- To install, run and stop the **database services** (aka. the DBMS), we use **Compose**.
- We use [DataGrip](#) by JetBrains to access the DBMS. The installation is usually not critical as it is just an application. Feel free to use your favourite tool if you like, such as pgAdmin.
- You can find sample data and also SQL scripts for the SQL lab in [GitHub](#). We assume that you have some knowledge of versioning and git. If not, let us know and we will help you.

VIRTUALISATION AND DOCKER FIGHTING SIDE EFFECTS

One question first



Docker

One way to install a DBMS with as few side effects as possible is to **virtualise** the database server and install it in a **Container**.

We will now **show you** how to install a system such as MariaDB or PostgreSQL in a Docker container and import our sample data. This is done using **Compose**.

e.g.



▼	database_course	Running (2/2)	0.14%
	ami_mariadb_data_warehouse 3a0fa8c175c1	mariadb:latest	Running
	ami_postgres_data_warehouse 7a9cd6531275	postgres:latest	Running 0% 5432:5432

Part of the Docker Desktop (free for educational use).

What does Compose do exactly?

"Compose is a tool for defining and running multi-container Docker applications. With Compose, you use a YAML file to configure your application's services. Then, with a single command, you create and start all the services from your configuration."

Docker Docs

Note: Podman with Compose is supported and works for the majority of use cases, though some advanced features may not be fully compatible.

So we provide a `compose.yml` with entries for MariaDB and PostgreSQL, and if the Docker or Podman installation is correct, that's it. Everything else, i.e. downloading the DBMS containers and launching the services, is done by Compose.

compose.yml Services

```
mariadb:  
  image: mariadb:latest  
  container_name: ami_mariadb_data_warehouse  
  environment:  
    MYSQL_ROOT_PASSWORD: root  
    MYSQL_ROOT_HOST: "%"  
  ports:  
    - "3312:3306"  
  volumes:  
    - ./mariadb_data:/var/lib/mysql  
  restart: always
```

```
postgres:  
  image: postgres:latest  
  container_name: ami_postgres_data_warehouse  
  environment:  
    POSTGRES_USER: root  
    POSTGRES_PASSWORD: root  
  ports:  
    - "5438:5432"  
  volumes:  
    - ./postgres_data:/var/lib/postgresql/data/  
  restart: always
```

services (mariadb and postgres) in compose.yml

Comments follow...

Some Remarks on Compose and compose.yml

- Since a container always starts with the same initial state (feature!), no data that has been changed will survive - which is not very sexy for a DBMS. Therefore, the container is usually given special locations, i.e. "shared folders", where the data can be stored. These are the **volumes-mappings** in compose.yml.
 - These directories are automatically created on the host machine.
- In compose.yml you can also see ports – a port mapping. Depending on what is installed on your machine, you will need to **adjust these ports**.
 - 3306 and 5432 (right sides) are the default ports for these two DBMSs running in the container. They map to the ports on the host (left sides), which are here 3312 and 5438 respectively. You can choose other ports or stick with these. We need these ports to connect to the DBMS.
- Of course, you will need to **replace the passwords** you see.

Commands to copy for your convenience, but first read more about them

- **git clone:**

```
% git clone https://github.com/codebasedlearning/database_course.git
```

- **start a database service (Docker)**

```
% docker compose -f docker/compose.yml up postgres -d
```

```
% docker compose -f docker/compose.yml up mariadb -d
```

- **stop a service (Docker)**

```
% docker compose -f docker/compose.yml down postgres
```

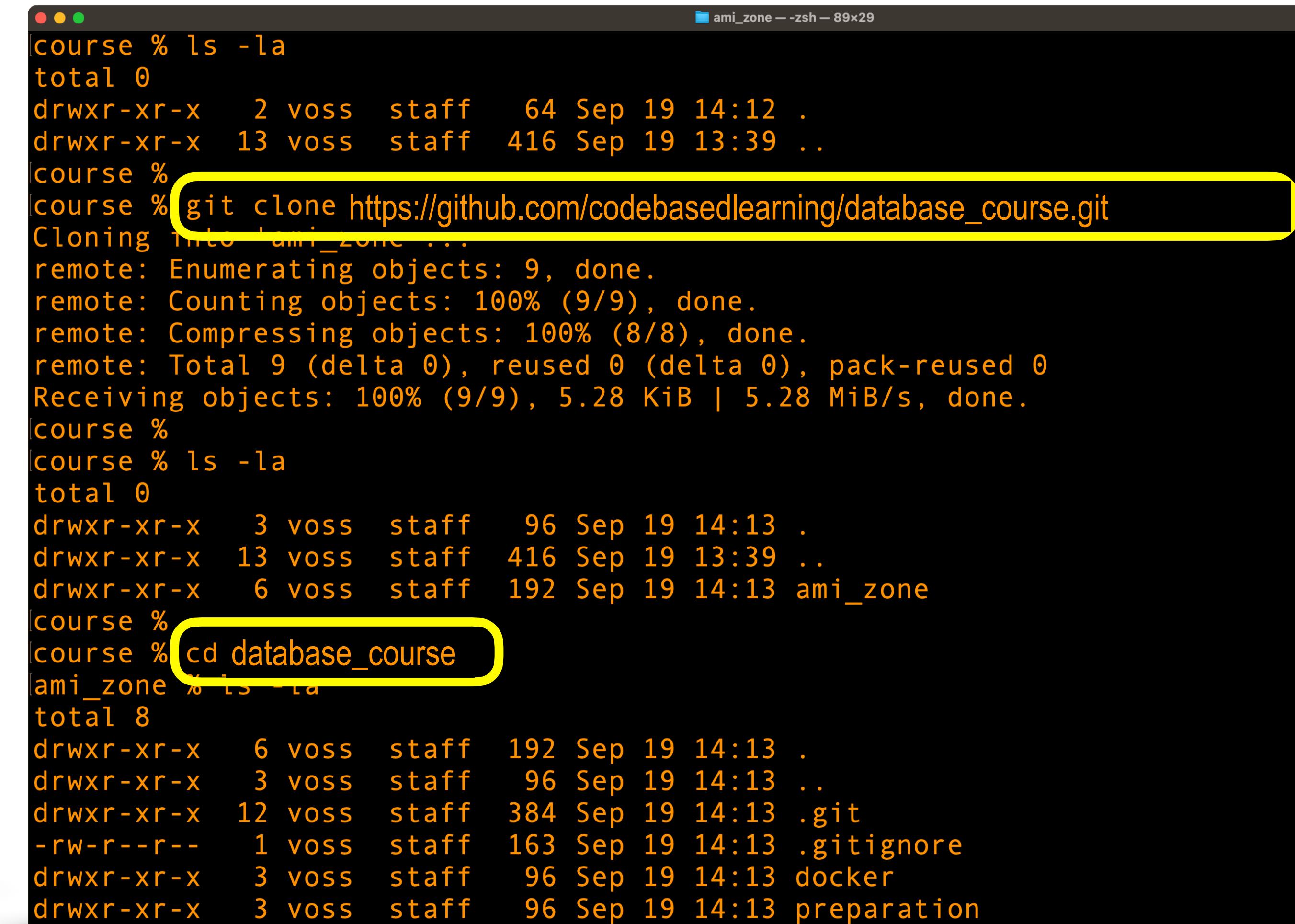
```
% docker compose -f docker/compose.yml down mariadb
```

Commands for the copy operations in the following text (without the % prompt)

Using Compose with Podman works, but it's slightly different. If you are familiar with Podman, you will already know how to start a container.

Installation Recipe Part I

- Start a terminal.
- Create or enter an empty folder, here `course`.
- Clone repository `database_course` from [GitHub](#).
- Enter new folder `database_course`.



```
course % ls -la
total 0
drwxr-xr-x  2 voss  staff   64 Sep 19 14:12 .
drwxr-xr-x 13 voss  staff  416 Sep 19 13:39 ..
course %
course % git clone https://github.com/codebasedlearning/database_course.git
Cloning into 'ami_zone' ...
remote: Enumerating objects: 9, done.
remote: Counting objects: 100% (9/9), done.
remote: Compressing objects: 100% (8/8), done.
remote: Total 9 (delta 0), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (9/9), 5.28 KiB | 5.28 MiB/s, done.
course %
course % ls -la
total 0
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 .
drwxr-xr-x 13 voss  staff  416 Sep 19 13:39 ..
drwxr-xr-x  6 voss  staff  192 Sep 19 14:13 ami_zone
course %
course % cd database_course
ami_zone % ls -la
total 8
drwxr-xr-x  6 voss  staff   192 Sep 19 14:13 .
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 ..
drwxr-xr-x 12 voss  staff  384 Sep 19 14:13 .git
-rw-r--r--  1 voss  staff  163 Sep 19 14:13 .gitignore
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 docker
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 preparation
```

Installation Recipe Part II

- Make sure that the configured port is not being used, e.g. by another container.
- Start and stop the DBMS via `compose` (see before), you can also find the commands in `compose.yml`.
- Confirm that the container is running.
- You will also see that the data directory has been created.

```
ami_zone % docker compose -f docker/compose.yml up mariadb -d
[+] Running 2/2
  ✓ Network database_course_default          Creat...
  ✓ Container ami_mariadb_data_warehouse     Started
ami_zone %
ami_zone % ls -la
total 8
drwxr-xr-x  7 voss  staff  224 Sep 19 14:24 .
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 ..
drwxr-xr-x 12 voss  staff  384 Sep 19 14:13 .git
-rw-r--r--  1 voss  staff  163 Sep 19 14:13 .gitignore
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 docker
drwxr-xr-x@ 12 voss  staff  384 Sep 19 14:24 mariadb_data
drwxr-xr-x  3 voss  staff   96 Sep 19 14:13 preparation
```

Here, MariaDB was started.

v	 database_course	Running (1/1)	0.07%	4 minutes ago	■
	 ami_mariadb_data_warehouse 705c4ae4b3dc	mariadb:latest	Running	0.07% 3312:3306 ↗	4 minutes ago

What has been, what is to come

- If all went well, you should now have
 - a **running installation** of a DBMS, and
 - a **data directory** where the data resides and will still be there when we restart.
 - We now **need to connect** to the DBMS so that we can
 - create data, schemes and tables, and
 - work with this data.
- We do this using DataGrip.

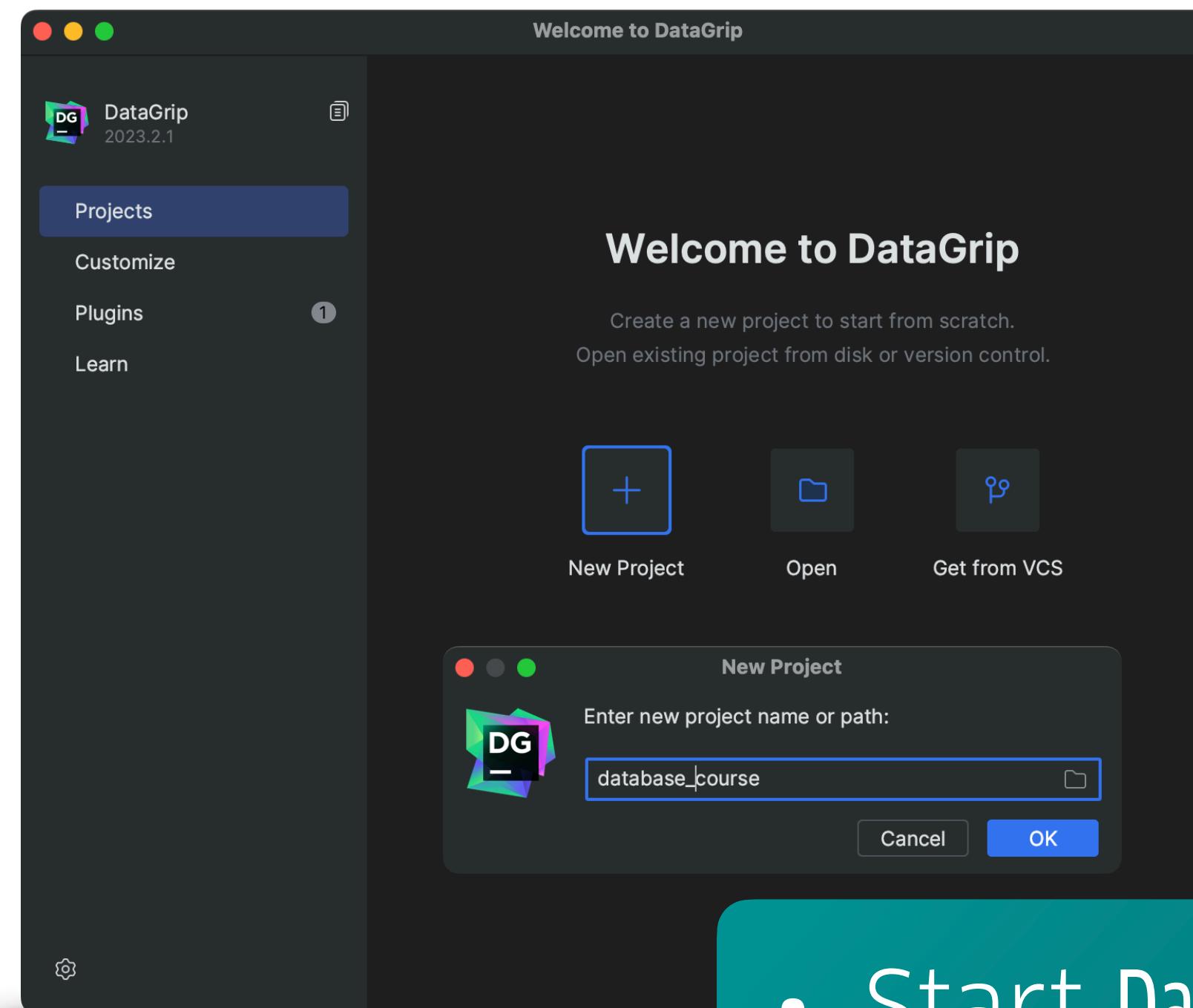


```
ami_zone -- zsh -- 89x29
14:55 .
14:50 ..
14:51 .git
14:13 .gitignore
14:13 docker
16:14 docs
16:14 exercises
18:29 mariadb_data
14:58 postgres_data
18:31 preparation
```

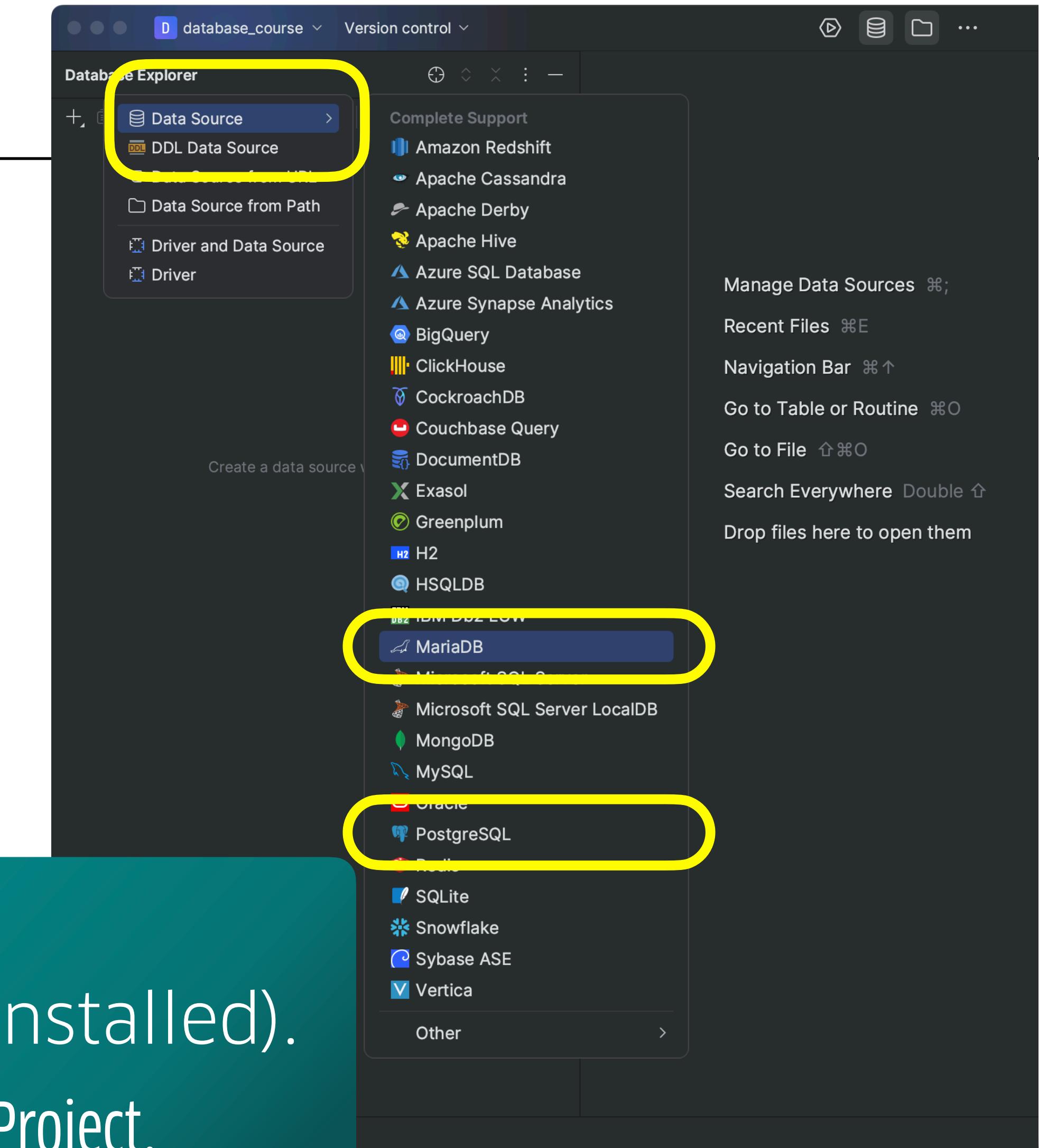
DATAGRIP

IDE FOR DATABASES

Connection Recipe Part I

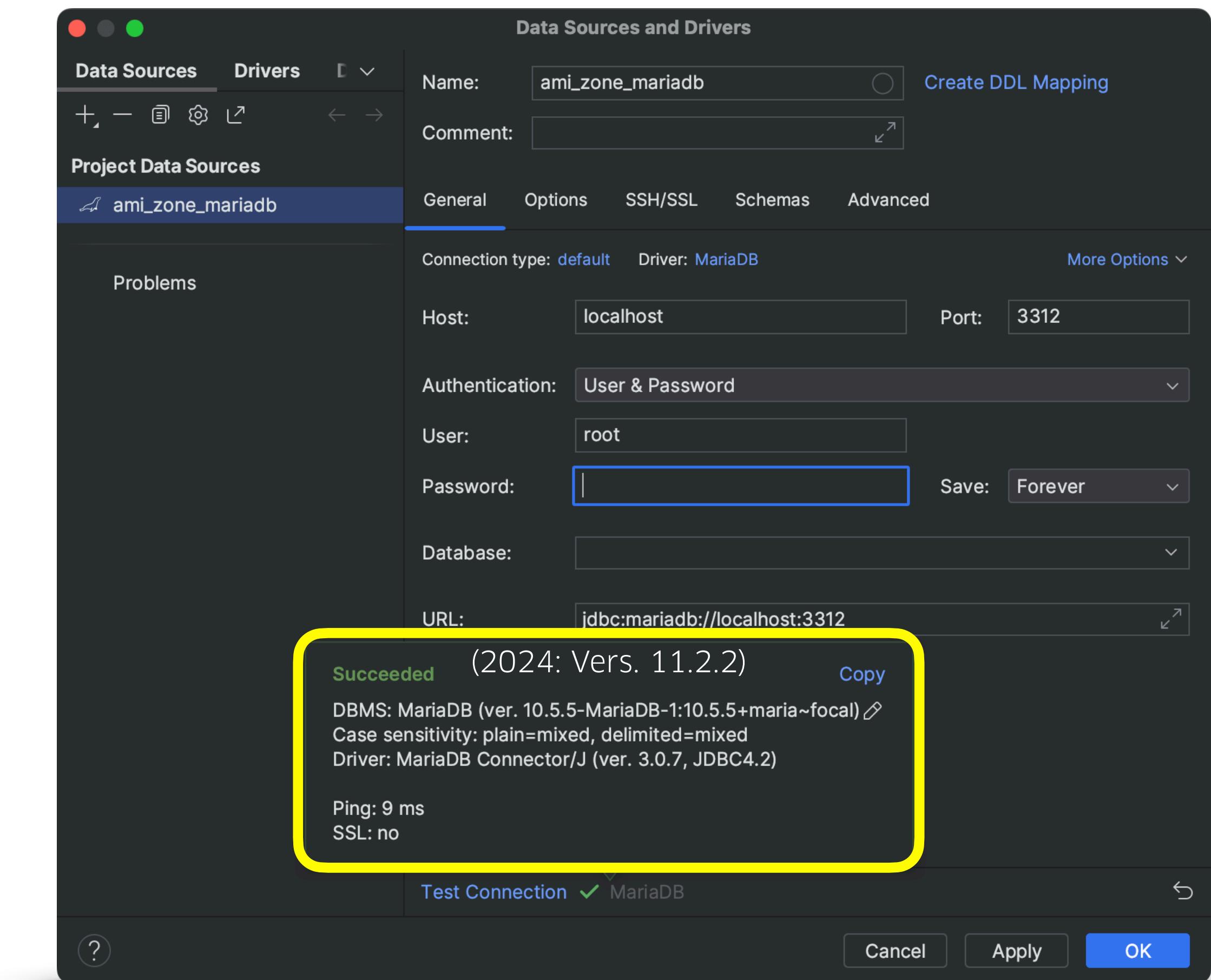


- Start DataGrip (if already installed).
- Choose New Project.
- Create new Data Source.



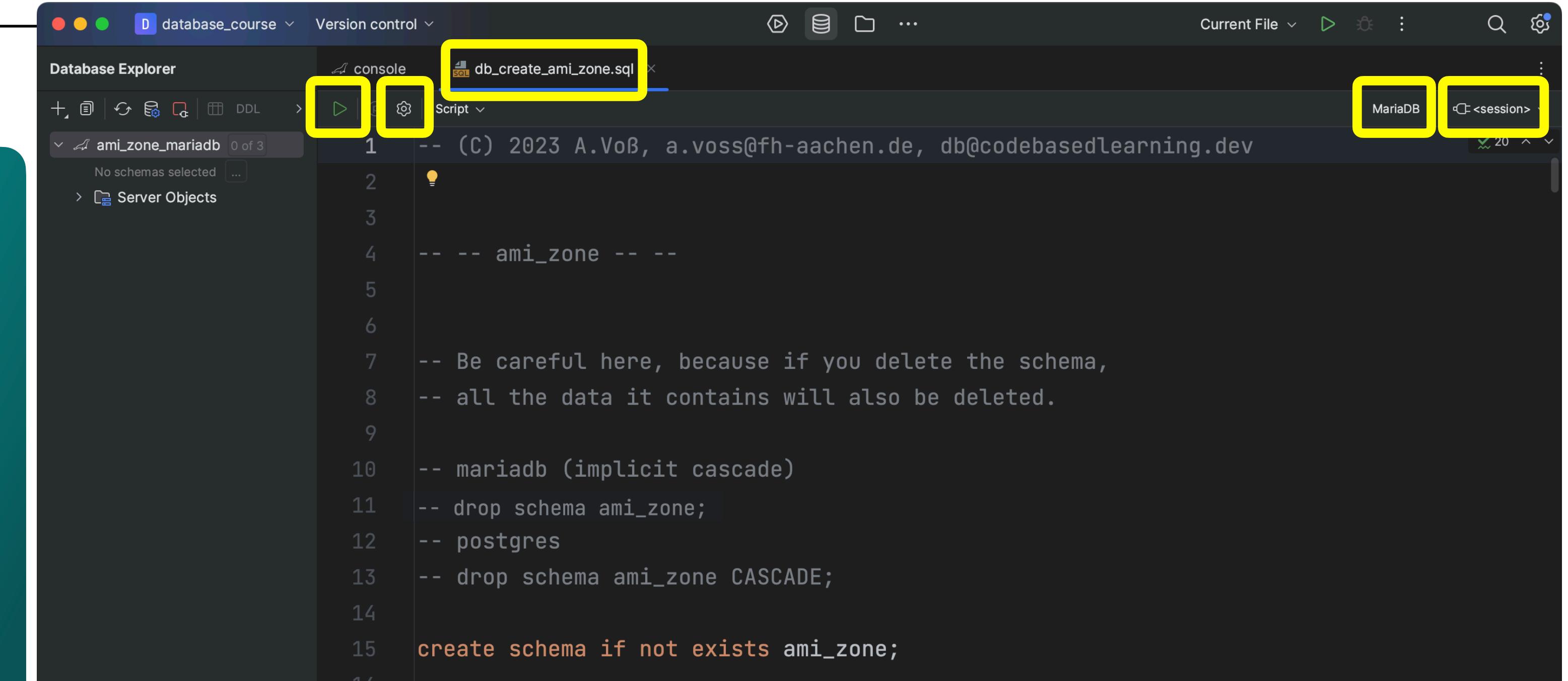
Connection Recipe Part II

- These are the project properties.
- Enter Name, Port, User, Password.
- Test Connection (maybe download missing drivers before)



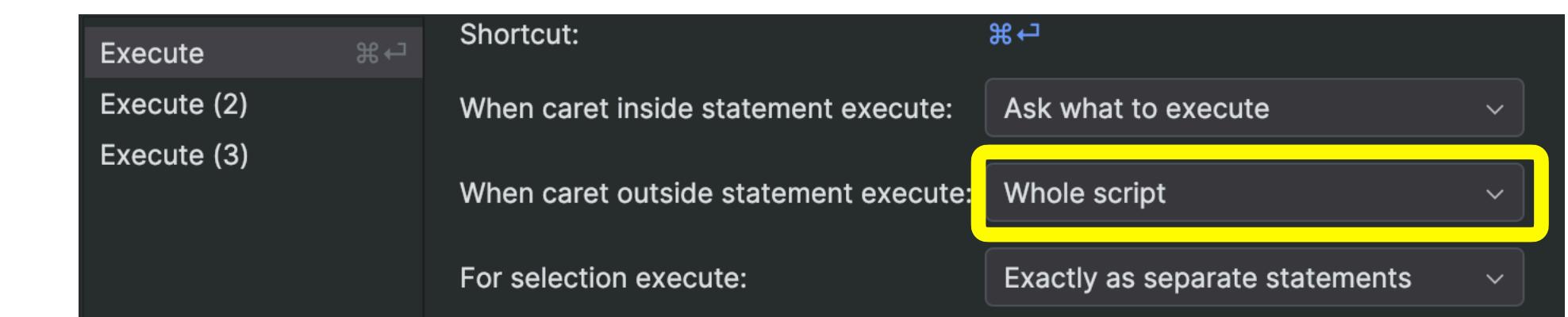
Installation Recipe Part III

- Drag and Drop db_create_ami_zone.sql from preparation into DataGrip.
- Select Dialect.
- Choose Console / New Session; or (2024) Settings 
- Place the cursor on a blank line and press Execute  (and hope).



```
-- -- ami_zone -- --
-- Be careful here, because if you delete the schema,
-- all the data it contains will also be deleted.
-- mariadb (implicit cascade)
-- drop schema ami_zone;
-- postgres
-- drop schema ami_zone CASCADE;
create schema if not exists ami_zone;
```

2024: Settings



Installation Recipe Part IV

Confirm that all tables have been created.

The screenshot shows the DataGrip interface with the following components:

- Database Explorer:** On the left, it shows the schema `ami_zone_mariadb` with 20 tables listed under the `tables` node. A yellow box highlights this list.
- SQL Console:** In the center, a SQL file named `db_create_ami_zone.sql` is open. The code creates a schema named `ami_zone` and lists 20 tables. The last line of the code is highlighted with a green checkmark.
- Services:** At the bottom, the Services tool window shows a transaction named `console` with a duration of 1s and 492 ms. It also lists the `db_create_ami_zone.sql` file.
- Status Bar:** At the bottom right, the status bar displays the text `[2023-09-19 14:48:05] 10 rows affected in 9 ms`.

Installation Recipe Part V

Check within console:

- `select * from ami_zone.shop_product;`

Note: the command `use` (see screenshot) is MariaDB-specific

The screenshot shows the DataGrip interface with the following components visible:

- Database Explorer:** Shows the database structure for `ami_zone_mariadb`, specifically the `ami_zone` schema which contains 20 tables.
- Console:** Displays the SQL command `use ami_zone;` followed by `select * from shop_product;`. The result of the query is shown in the Output pane.
- Output:** Shows the results of the `select * from shop_product;` query, listing seven items with their details:

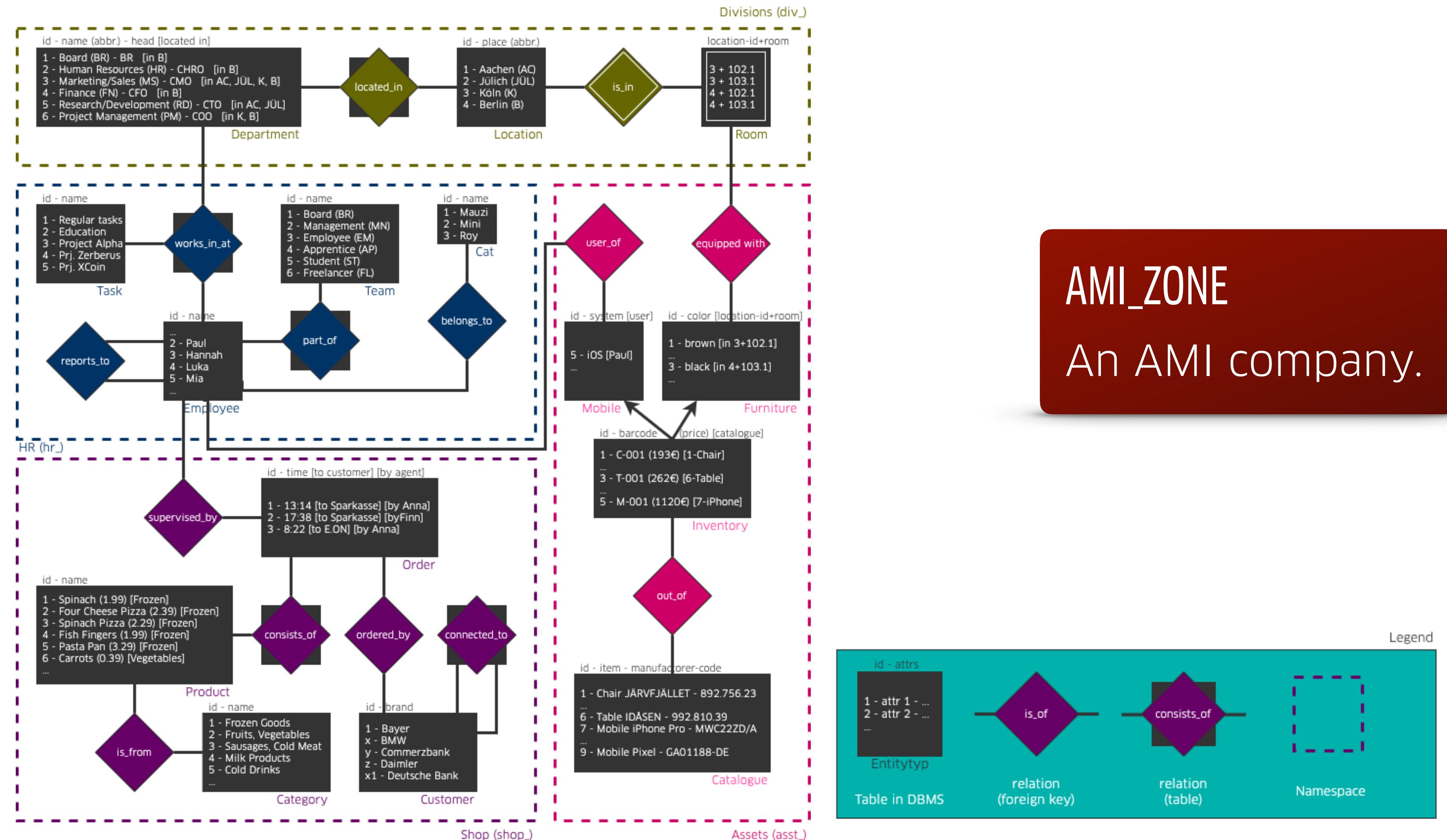
ID	Name	Category ID	Unit
1	Spinach	1	PK
2	Four Cheese Pizza	2	PC
3	Spinach Pizza	3	PC
4	Fish Fingers	4	PK
5	Pasta Pan	5	PK
6	Carrots	6	KG
7	Onions	7	KG

Concluding remarks on the steps taken

- The Dialect helps with syntax support because SQL commands (unfortunately) differ in detail.
- The execution of a single command or script takes place in a Session associated with a particular DBMS. You can also change this session if you have more than one DBMS connected.
- If you want to repeat the whole creation process, you can delete the so-called schema (or database), a kind of namespace. This will also delete all the tables. The command (drop schema) can be used in MariaDB for this, remove the comment (--) according to your DBMS.
- If any **code is selected**, the **left green arrow**  at the top left of the code will execute that selection. If the cursor is on a blank line, the **script will be executed**. Otherwise, the **current command is executed**, starting from the current line.

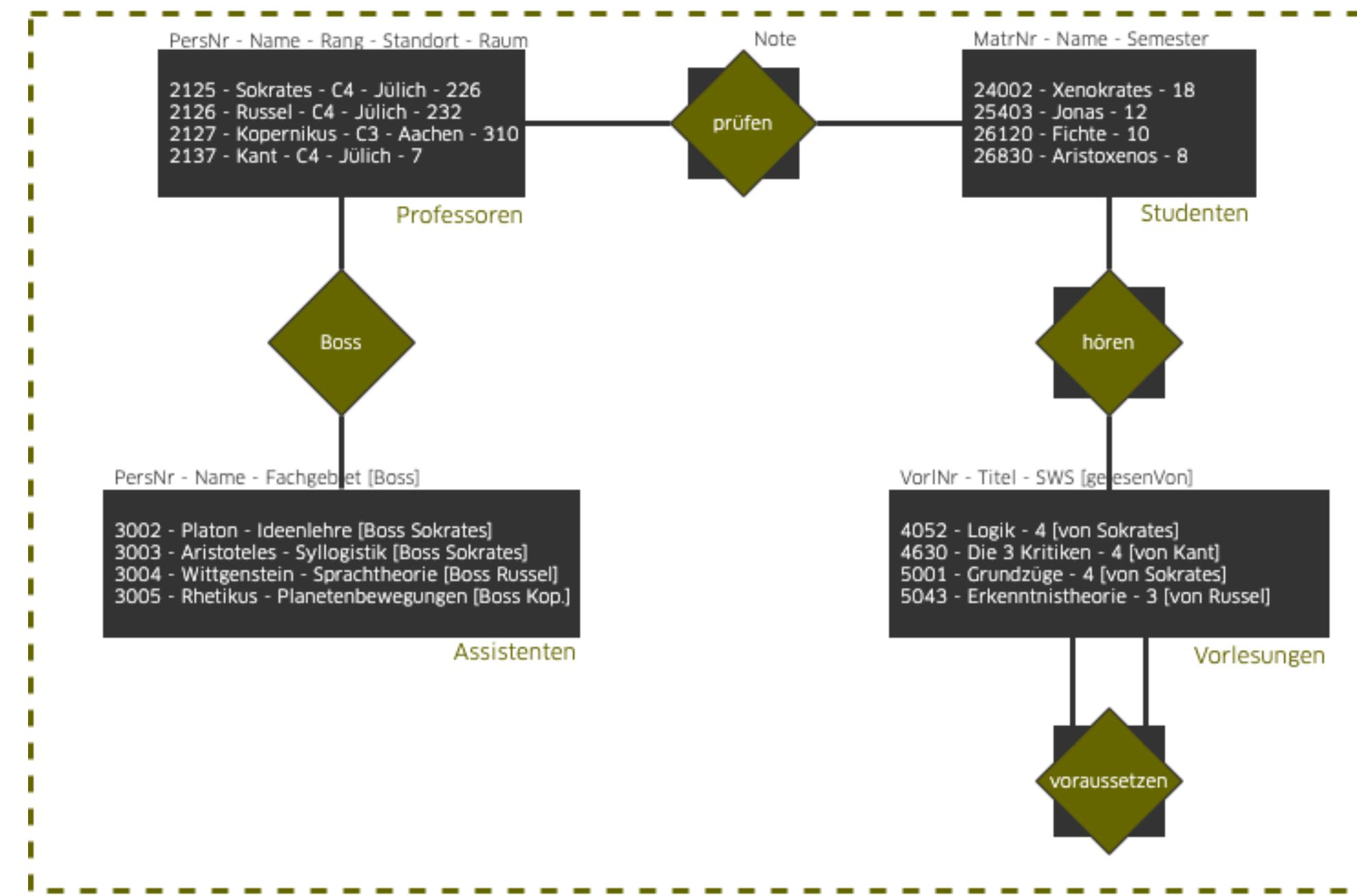
SAMPLE DATA

Main sample database



AMI_ZONE
An AMI company.

Sample database, used in exams



AMI_KEMPER
Datenbanksysteme
(Kemper, Eickler)

