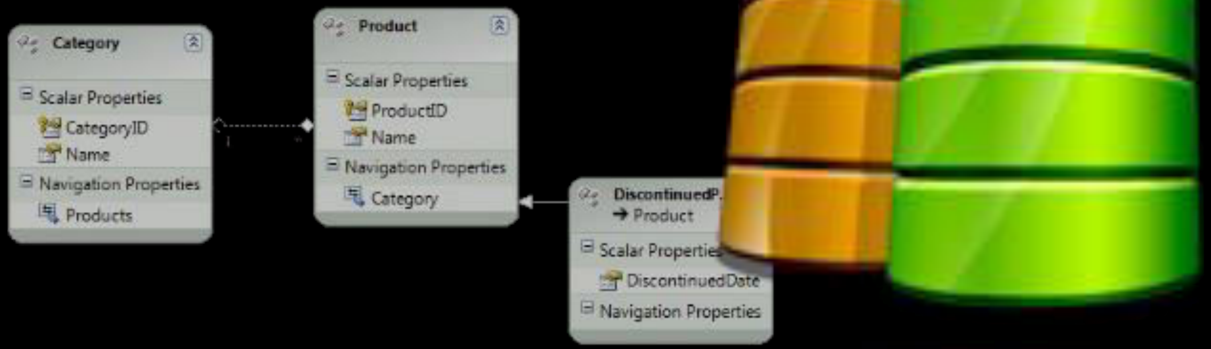
Table Relations

Database Design and Rules



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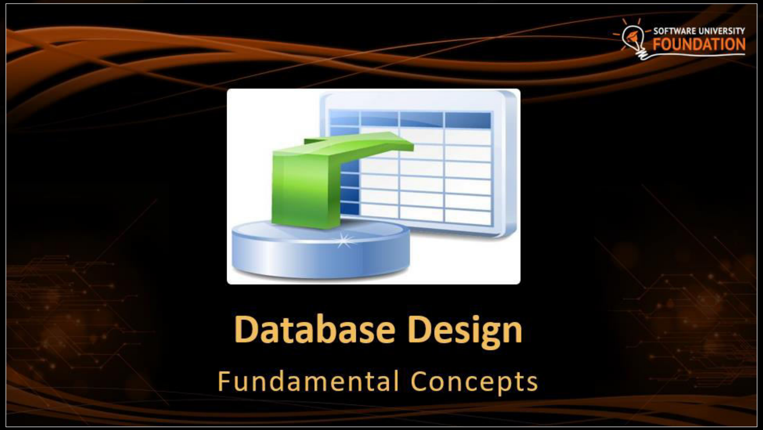
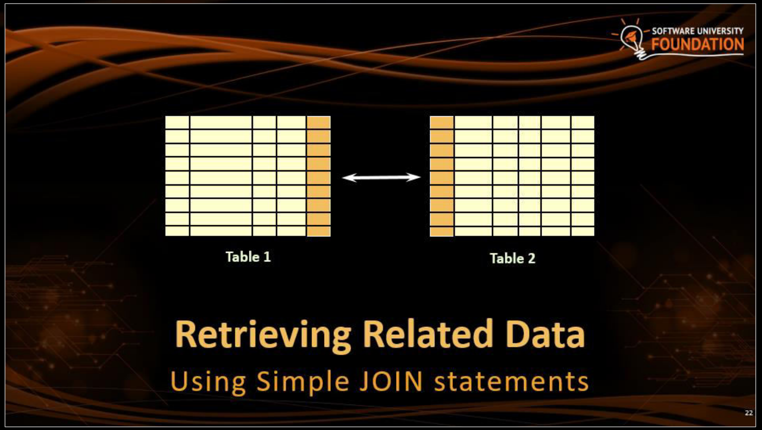


Database Design

Fundamental Concepts

Table Relations

Relational Database Model in Action

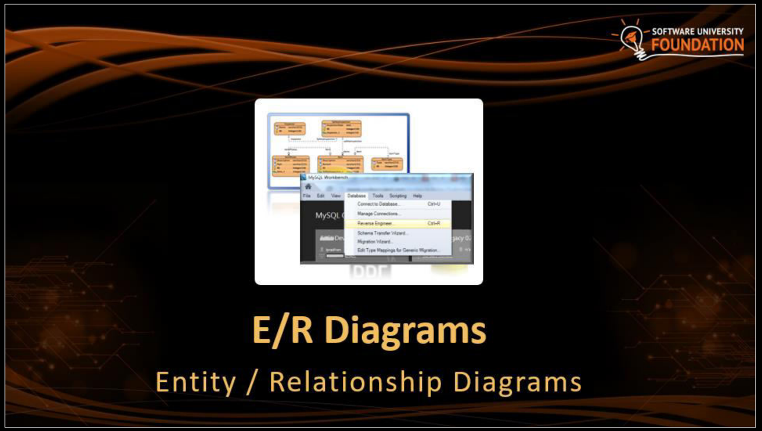


Retrieving Related Data

Using Simple JOIN statements

Cascade Operations

Cascade Delete/Update



E/R Diagrams

Entity / Relationship Diagrams

Questions

sli.do

#JavaDB

Database Design

Fundamental Concepts

Steps in Database Design

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1. Identification of the entities
2. Defining table columns
3. Defining primary keys
4. Modeling relationships
5. Defining constraints
6. Filling test data

Identification of Entities

- Entity tables represent objects from the real world
  - Most often they are nouns in the specification
  - For example:

```
We need to develop a system that stores
information about students, which are trained
in various courses. The courses are held in
different towns. When registering a new
student the following information is entered:
name, faculty number, photo and date.
```

  - Entities: **Student**, **Course**, **Town**

Identification of the Columns

- Columns are clarifications for the entities in the text of the specification, for example:

```
We need to develop a system that stores
information about students, which are trained
in various courses. The courses are held in
different towns. When registering a new
student the following information is entered:
name, faculty number, photo and date.
```

- Students have the following characteristics:
  - Name, faculty number, photo, date of enlistment and a list of courses they visit

How to Choose a Primary Key?

- Always define an additional column for the primary key
  - Don't use an existing column (for example SSN)
  - Must be an integer number
  - Must be declared as a **`PRIMARY KEY`**
  - Use **`auto_increment`** to implement auto-increment
  - Put the primary key as a first column
- Exceptions
  - Entities that have well known ID, e.g. countries (BG, DE, US) and currencies (USD, EUR, BGN)

Identification of Relationships

- Relationships are dependencies between the entities:

```
We need to develop a system that stores
information about students, which are trained in
various courses. The courses are held in
different towns. When registering a new student
the following information is entered: name,
faculty number, photo and date.
```

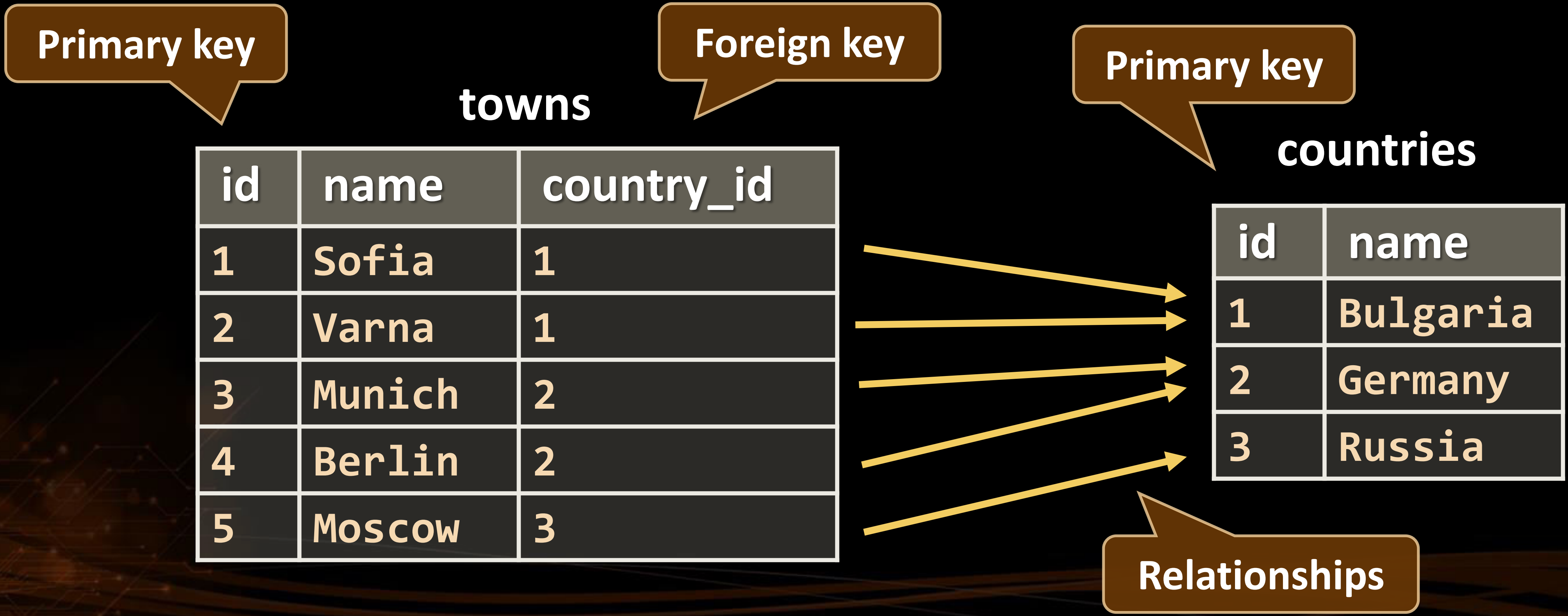
- "Students are trained in courses" – many-to-many relationship.
- "Courses are held in towns" – many-to-one (or many-to-many) relationship

Table Relations

Relational Database Model in Action

Relationships

- Relationships between tables are based on interconnections: **PRIMARY KEY / FOREIGN KEY**



towns

id	name	country_id
1	Sofia	1
2	Varna	1
3	Munich	2
4	Berlin	2
5	Moscow	3

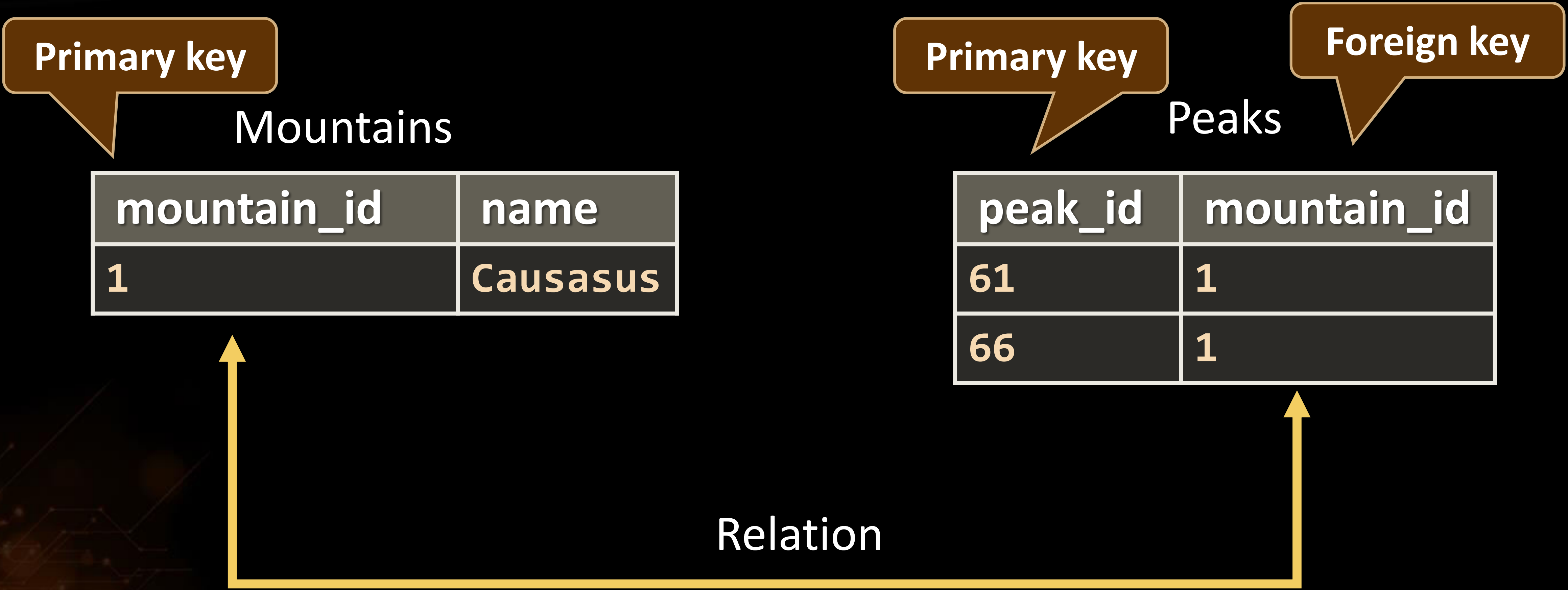
countries

id	name
1	Bulgaria
2	Germany
3	Russia

Relationships (2)

- The foreign key is an identifier of a record located in another table (usually its primary key)
- By using relationships we avoid repeating data in the database
- Relationships have multiplicity:
  - **One-to-many** – e.g. country / towns
  - **Many-to-many** – e.g. student / course
  - **One-to-one** – e.g. example driver / car

One-to-Many/Many-to-One



Mountains

mountain_id	name
1	Causasus

Peaks

peak_id	mountain_id
61	1
66	1

Setup

```
CREATE TABLE mountains(
  mountain_id INT PRIMARY KEY,
  mountain_name VARCHAR(50)
);
CREATE TABLE peaks(
  peak_id INT PRIMARY KEY,
  mountain_id INT,
  CONSTRAINT fk_peaks_mountains
  FOREIGN KEY (mountain_id)
  REFERENCES mountains(mountain_id)
);
```

Primary key

Table Peaks

Foreign Key

Foreign Key

Constraint Name

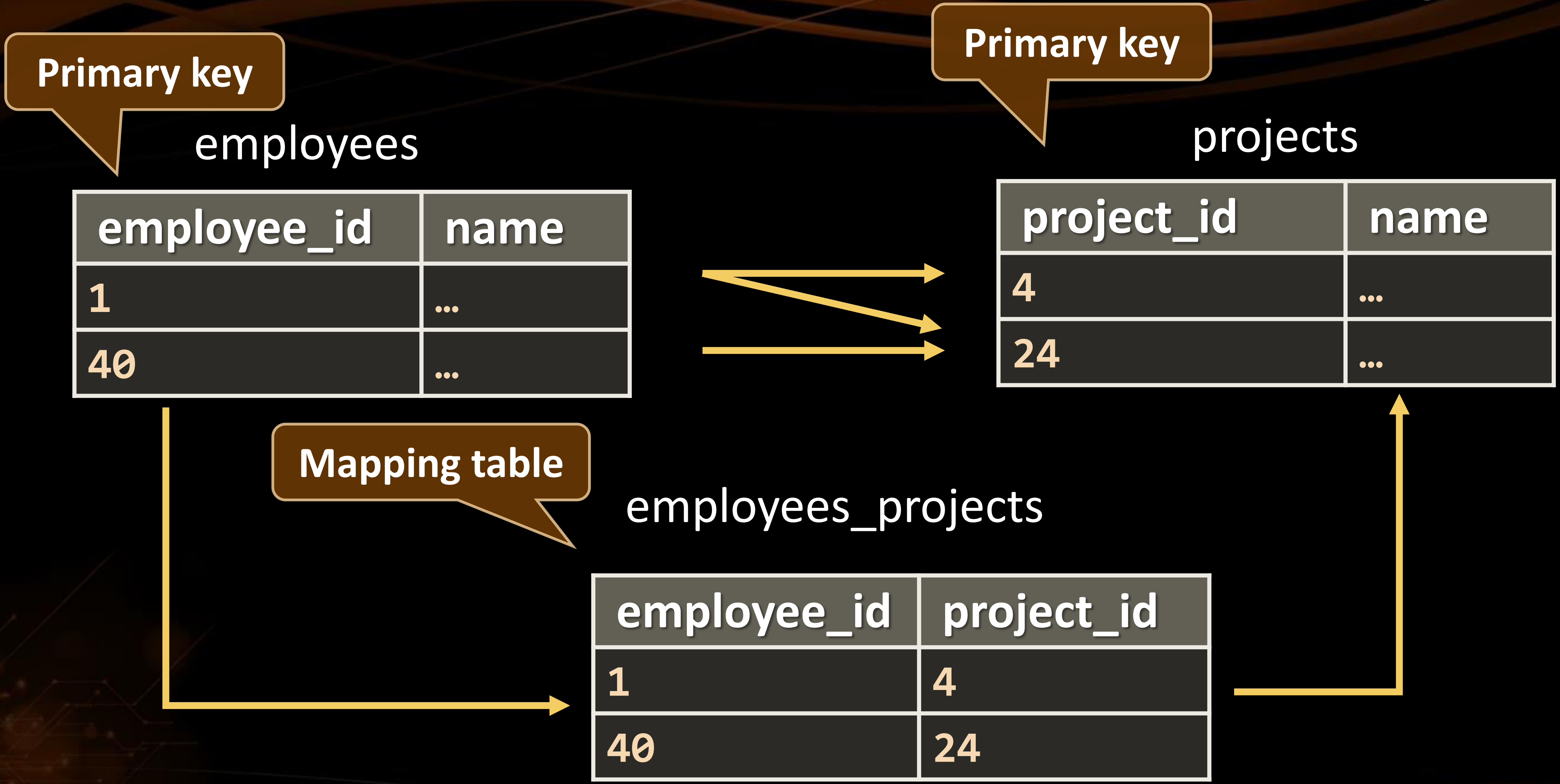
```
CONSTRAINT fk_peaks_mountains
FOREIGN KEY (mountain_id)
REFERENCES mountains(mountain_id);
```

Foreign Key

Referent Table

Primary Key

Many-to-Many



employees

employee_id	name
1	…
40	…

projects

project_id	name
4	…
24	…

employees_projects

employee_id	project_id
1	4
40	24

Setup(1)

```
CREATE TABLE employees(
  employee_id INT PRIMARY KEY,
  employee_name VARCHAR(50)
);
```

Table Employees

```
CREATE TABLE projects(
  project_id INT PRIMARY KEY,
  project_name VARCHAR(50)
);
```

Table Projects

Setup(2)

Mapping Table

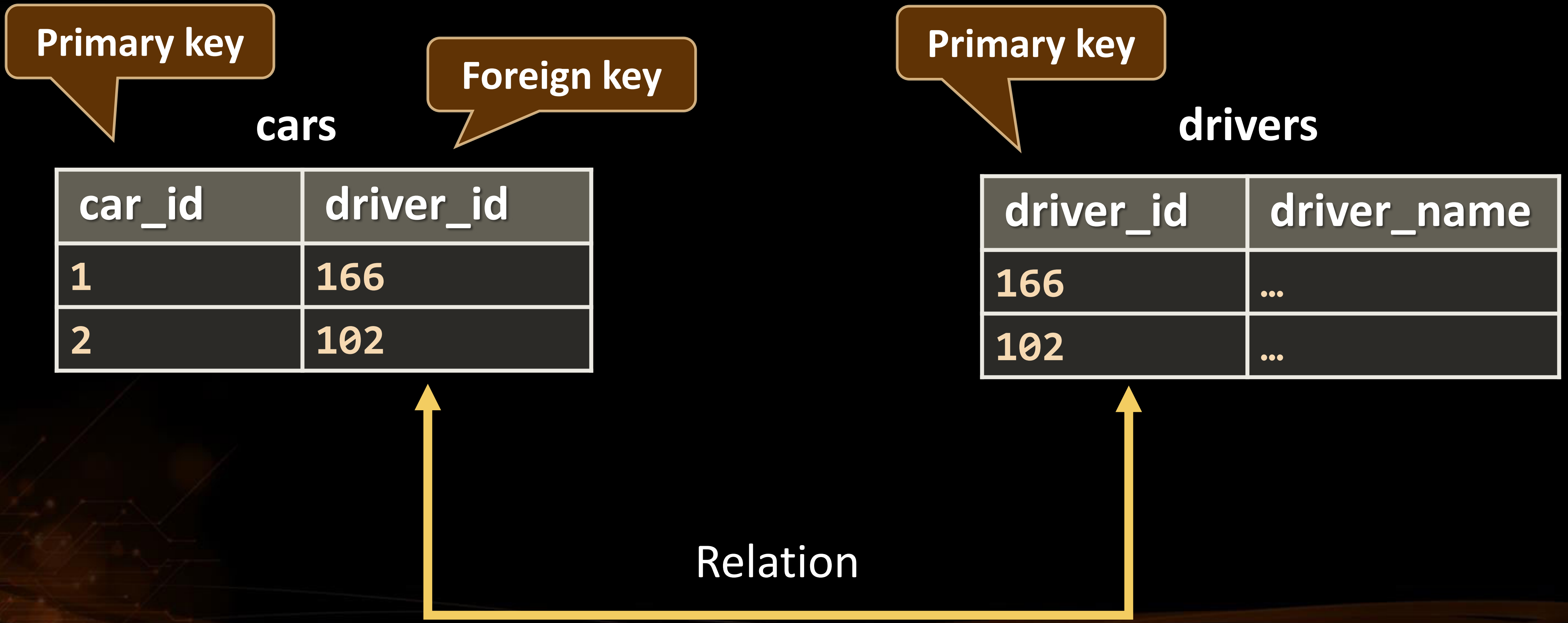
```
CREATE TABLE employees_projects(
  employee_id INT,
  project_id INT,
  CONSTRAINT pk_employees_projects
  PRIMARY KEY(employee_id, project_id),
  CONSTRAINT fk_employees_projects_employees
  FOREIGN KEY(employee_id)
  REFERENCES employees(employee_id),
  CONSTRAINT fk_employees_projects_projects
  FOREIGN KEY(project_id)
  REFERENCES projects(project_id)
);
```

Primary Key

Foreign Key

Foreign Key

One-to-One



cars

car_id	driver_id
1	166
2	102

drivers

driver_id	driver_name
166	…
102	…

Setup

```
CREATE TABLE drivers(
  driver_id INT PRIMARY KEY,
  driver_name VARCHAR(50)
);

CREATE TABLE cars(
  car_id INT PRIMARY KEY,
  driver_id INT UNIQUE,
  CONSTRAINT fk_cars_drivers FOREIGN KEY
  (driver_id) REFERENCES drivers(driver_id)
);
```

Primary key

One driver per car

Foreign Key

Foreign Key

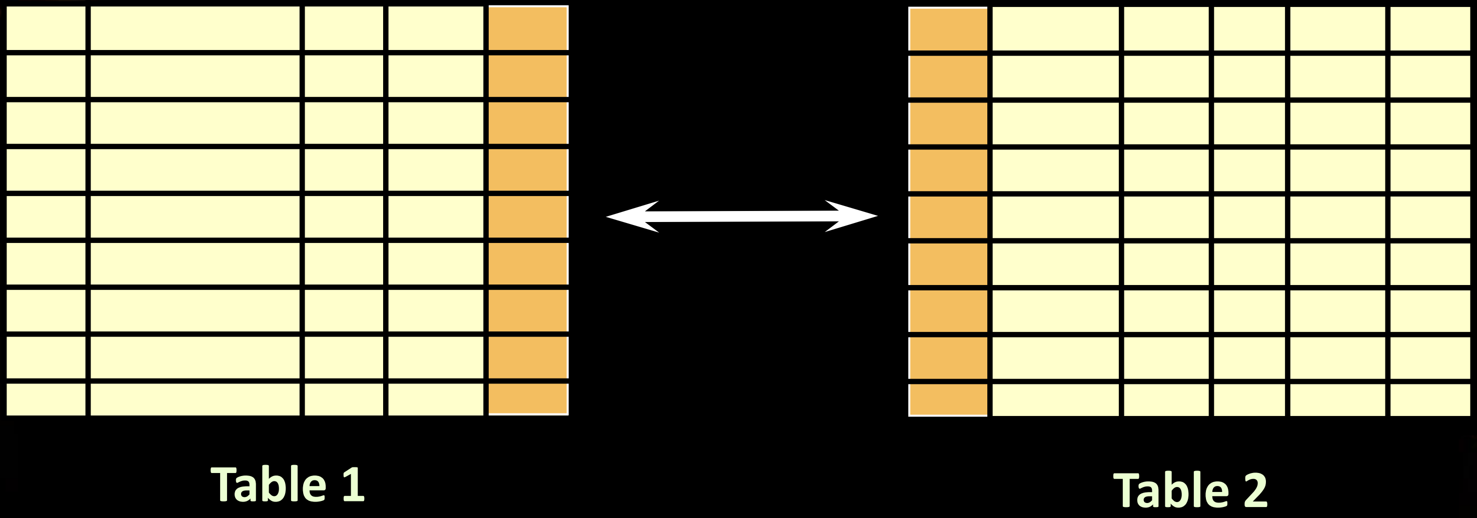
Constraint Name

```
CONSTRAINT fk_cars_drivers
FOREIGN KEY (driver_id)
REFERENCES drivers(driver_id)
```

Foreign Key

Referent Table

Primary Key



Retrieving Related Data

Using Simple JOIN statements

Joins

- Table relations are useful when combined with JOINS
- With JOINS we can get data from two tables simultaneously
  - JOINS require at least two tables and a "join condition"
  - Example:

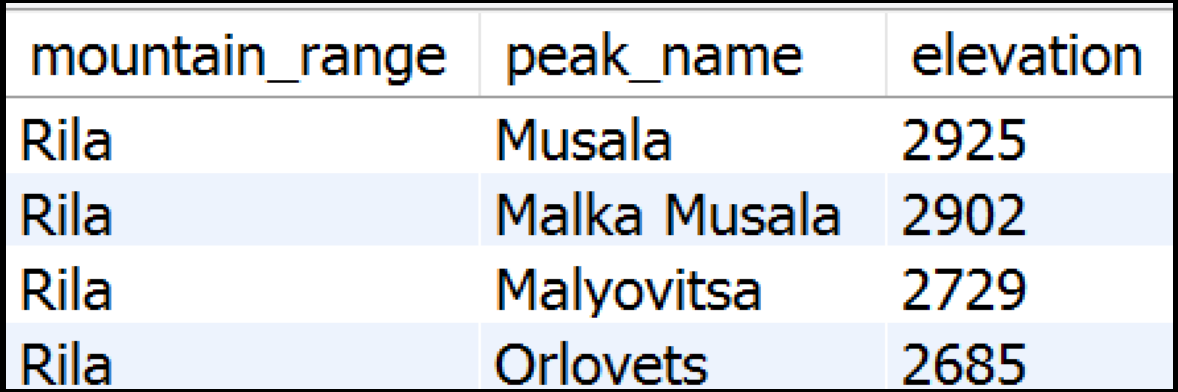
Select from Tables

```
SELECT * FROM table_a
  JOIN table_b ON
    table_b.common_column = table_a.common_column
```

Join Condition

Problem: Peaks in Rila

- Report all peaks for "Rila" mountain.
  - Report includes mountain's name, peak's name and also peak's elevation
  - Peaks should be sorted by elevation descending
  - Use database "Geography".



mountain_range	peak_name	elevation
Rila	Musala	2925
Rila	Malka Musala	2902
Rila	Malyovitsa	2729
Rila	Orlovets	2685

Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/605#6

Solution: Peaks in Rila

Cross Table Selection

```
SELECT m.mountain_range, p.peak_name, p.elevation
  FROM peaks AS p
  JOIN mountains AS m ON m.id = p.mountain_id
  WHERE m.mountain_range = 'Rila'
  ORDER BY p.elevation DESC;
```

Join Condition

Sort

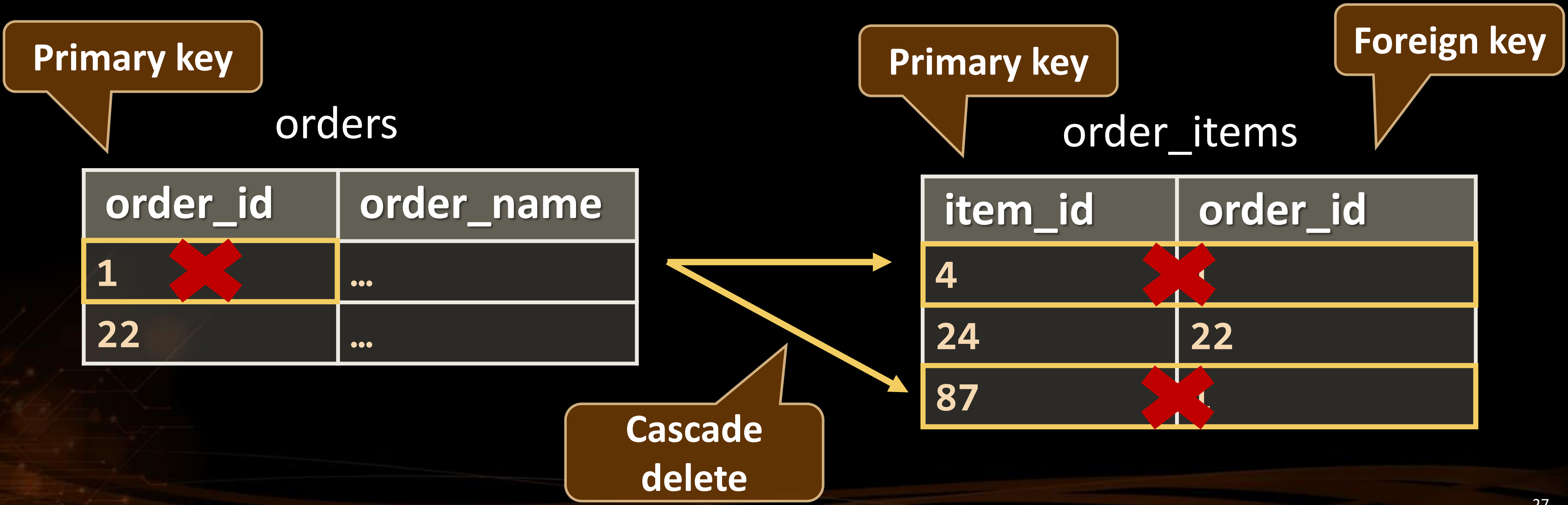
Check your solution here: https://judge.softuni.bg/Contests/Practice/Index/605#6

Cascade Operations

Cascade Delete/Update

Definition

- Cascading allows when a change is made to certain entity, this change to apply to all related entities



orders

order_id	order_name
1	…
22	…

order_items

item_id	order_id
4	1
24	22
87	1

CASCADE DELETE

- **CASCADE** can be either **DELETE** or **UPDATE**.
- Use **CASCADE DELETE** when:
  - The related entities are meaningless without the "main" one
- Do not use **CASCADE DELETE** when:
  - You make "logical delete"
  - You preserve history
  - Keep in mind that in more complicated relations it won't work with circular references

CASCADE UPDATE

- Use **CASCADE UPDATE** when:
  - The primary key is **NOT** identity (not **`auto-increment`**) and therefore it can be changed
  - Best used with **`UNIQUE`** constraint
- Do not use **CASCADE UPDATE** when:
  - The primary is identity (**`auto-increment`**)
- Cascading can be avoided using triggers or procedures

Foreign Key Delete Cascade

```
CREATE TABLE drivers(
  driver_id INT PRIMARY KEY,
  driver_name VARCHAR(50)
);

CREATE TABLE cars(
  car_id INT PRIMARY KEY,
  driver_id INT,
  CONSTRAINT fk_car_driver FOREIGN KEY(driver_id)
  REFERENCES drivers(driver_id) ON DELETE CASCADE
);
```

Table Drivers

Table Cars

Foreign Key

Foreign Key Update Cascade

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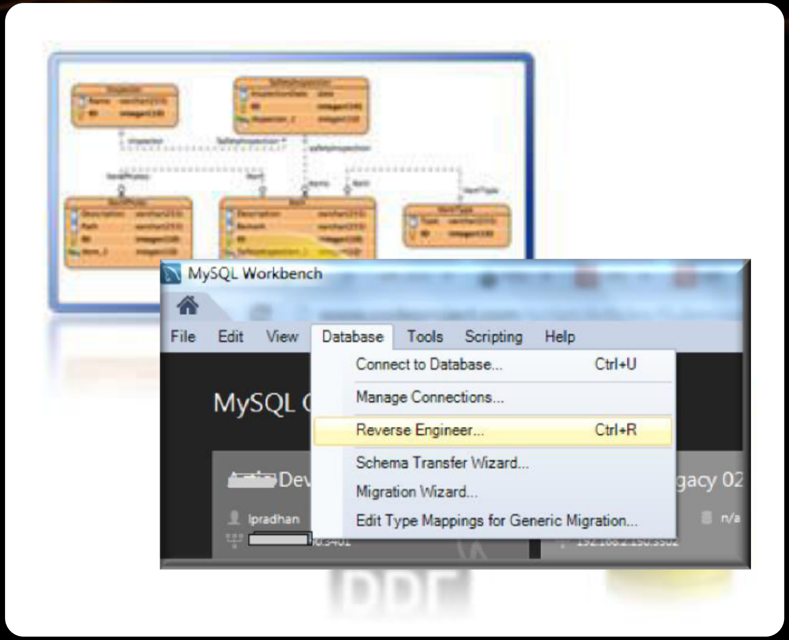
```
CREATE TABLE drivers(
   driver_id INT PRIMARY KEY,
   driver_name VARCHAR(50)
);

CREATE TABLE cars(
   car_id INT PRIMARY KEY,
   driver_id INT,
   CONSTRAINT fk_car_driver FOREIGN KEY(driver_id)
   REFERENCES drivers(driver_id) ON UPDATE CASCADE
);
```

Table Drivers

Table Cars

Foreign Key


MySQL Workbench
File
Edit
View
Database
Tools
Scripting
Help
Connect to Database... Ctrl+U
Manage Connections...
Reverse Engineer... Ctrl+R
Schema Transfer Wizard...
Migration Wizard...
Edit Type Mappings for Generic Migration...

E/R Diagrams

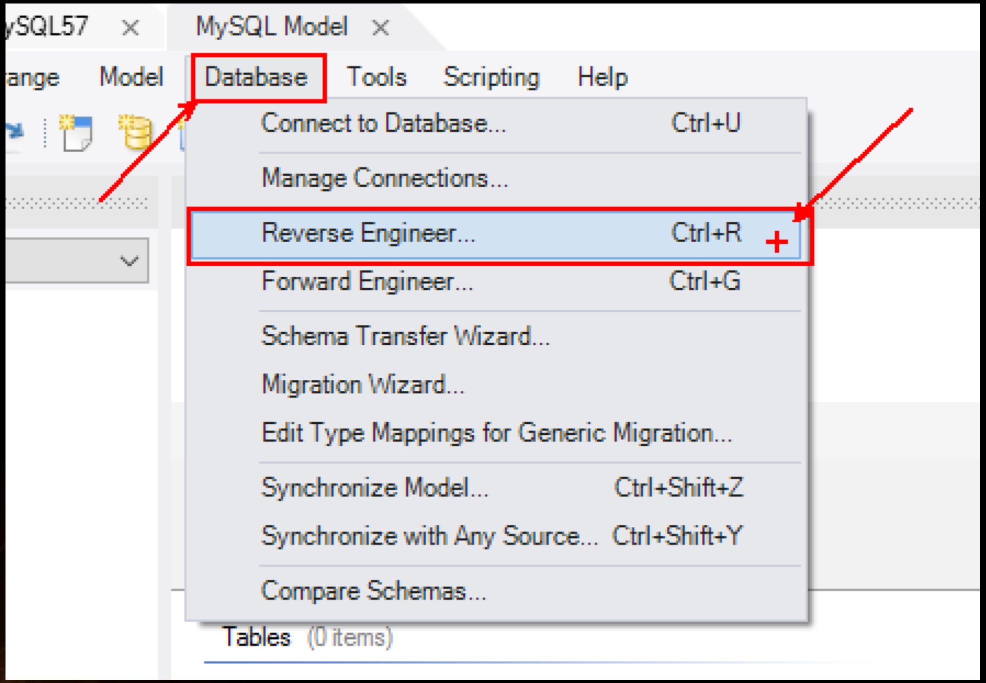
Entity / Relationship Diagrams

Relational Schema

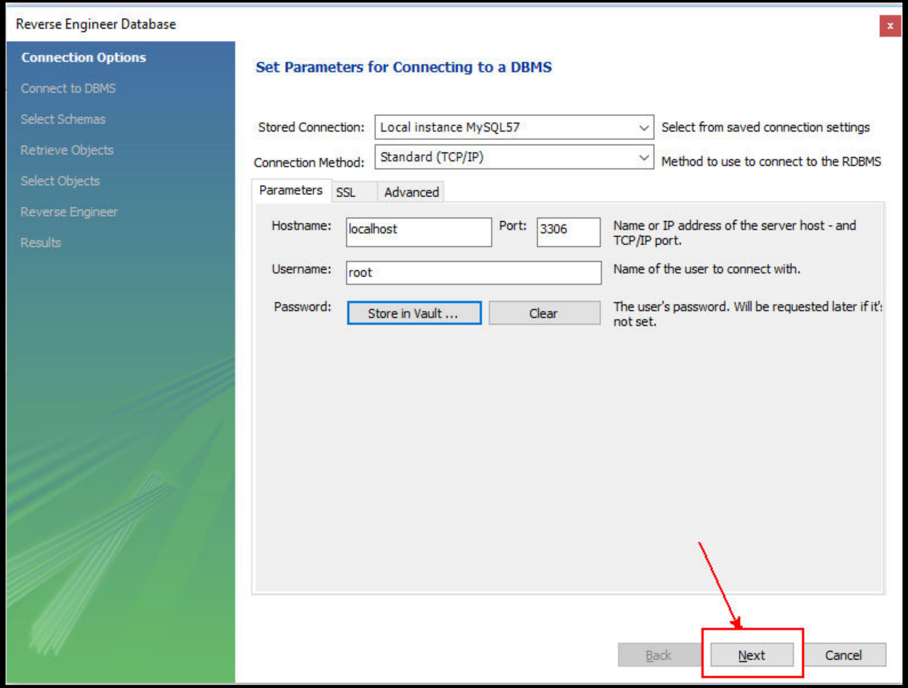
- Relational schema of a DB is the collection of:
  - The schemas of all tables
  - Relationships between the tables
  - Any other database objects (e.g. constraints)
- The relational schema describes the structure of the database
  - Doesn't contain data, but metadata
- Relational schemas are graphically displayed in Entity / Relationship diagrams (E/R Diagrams)

E/R Diagram

- Click on "Database" then select "Reverse Engineer"



ySQL57
MySQL Model
ange
Model
Database
Tools
Scripting
Help
Connect to Database... Ctrl+U
Manage Connections...
Reverse Engineer... Ctrl+R
Forward Engineer... Ctrl+G
Schema Transfer Wizard...
Migration Wizard...
Edit Type Mappings for Generic Migration...
Synchronize Model... Ctrl+Shift+Z
Synchronize with Any Source... Ctrl+Shift+Y
Compare Schemas...
Tables (0 items)



Set Parameters for Connecting to a DBMS

Stored Connection: Local instance MySQL57 — Select from saved connection settings

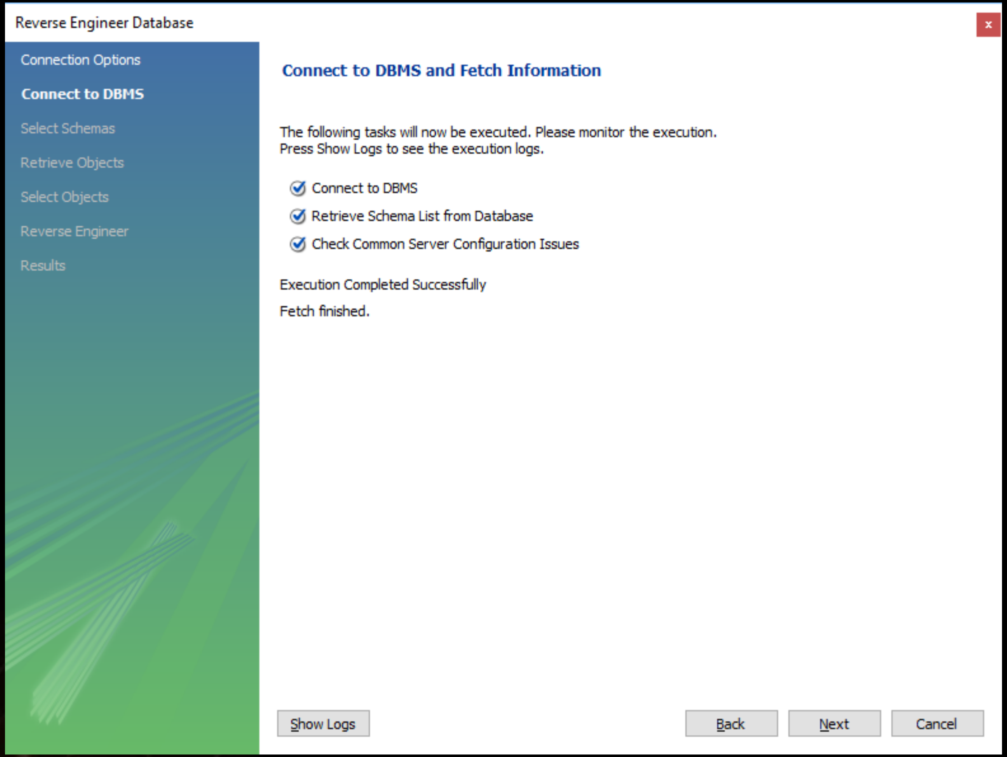
Connection Method: Standard (TCP/IP) — Method to use to connect to the RDBMS

Hostname: localhost Port: 3306 — Name or IP address of the server host - and TCP/IP port.

Username: root — Name of the user to connect with.

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

E/R Diagram



Reverse Engineer Database

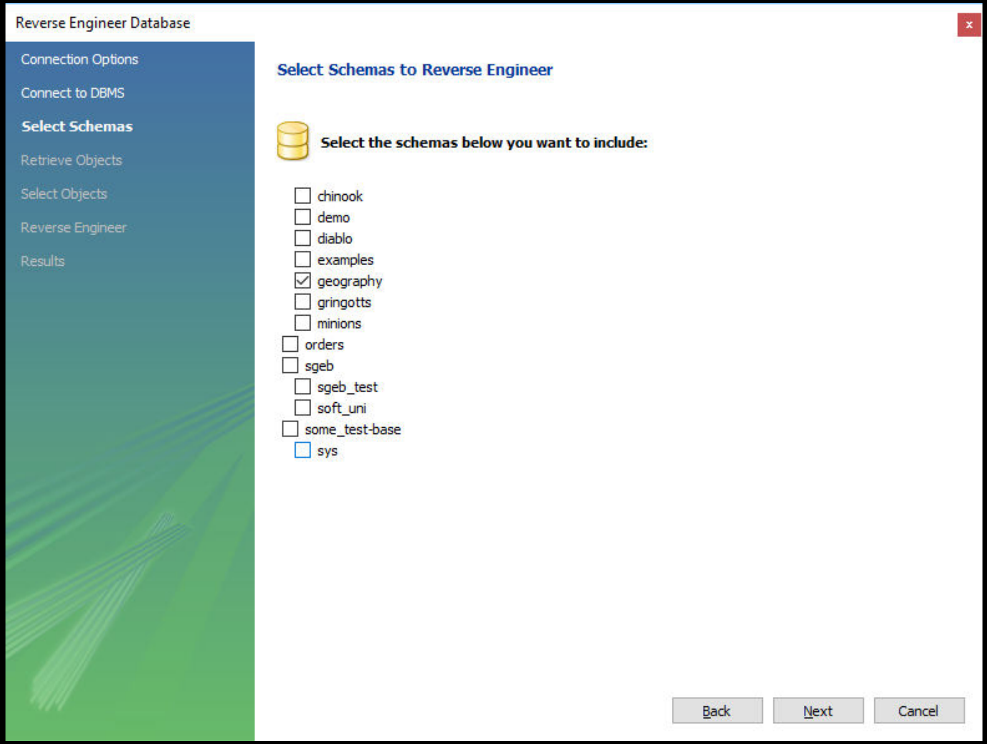
Connect to DBMS and Fetch Information

The following tasks will now be executed. Please monitor the execution.
Press Show Logs to see the execution logs.

- ✓ Connect to DBMS
- ✓ Retrieve Schema List from Database
- ✓ Check Common Server Configuration Issues

Execution Completed Successfully

Fetch finished.



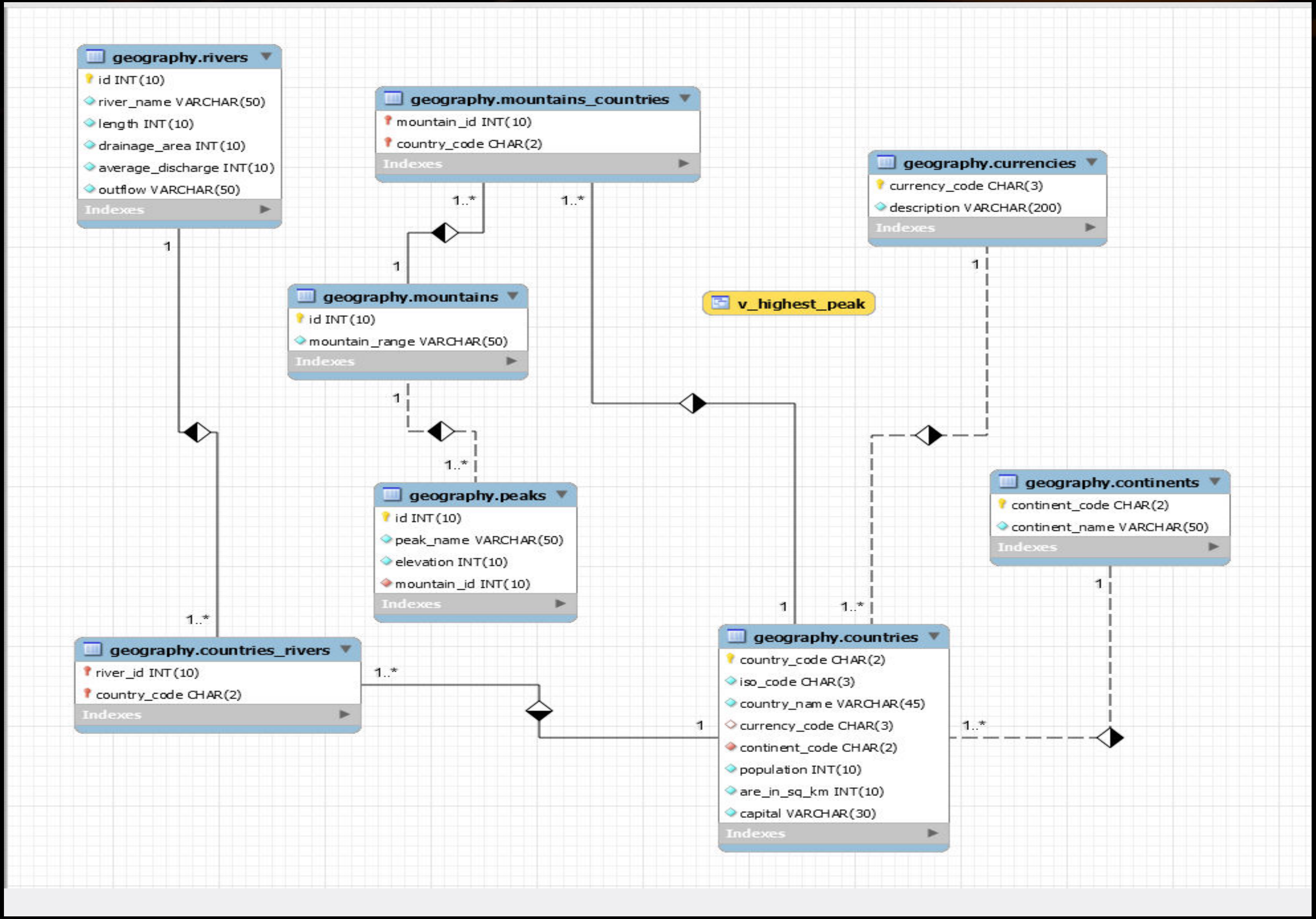
Reverse Engineer Database

Select Schemas to Reverse Engineer

Select the schemas below you want to include:

- ☐ chinook
- ☐ demo
- ☐ diablo
- ☐ examples
- ☑ geography
- ☐ gringotts
- ☐ minions
- ☐ orders
- ☐ sgeb
- ☐ sgeb_test
- ☐ soft_uni
- ☐ some_test-base
- ☐ sys

E/R Diagram


geography.rivers
id INT(10)
river_name VARCHAR(50)
length INT(10)
drainage_area INT(10)
average_discharge INT(10)
outflow VARCHAR(50)
Indexes
geography.mountains_countries
mountain_id INT(10)
country_code CHAR(2)
Indexes
geography.currencies
currency_code CHAR(3)
description VARCHAR(200)
Indexes
geography.mountains
id INT(10)
mountain_range VARCHAR(50)
Indexes
v_highest_peak
geography.peaks
id INT(10)
peak_name VARCHAR(50)
elevation INT(10)
mountain_id INT(10)
Indexes
geography.continents
continent_code CHAR(2)
continent_name VARCHAR(50)
Indexes
geography.countries_rivers
river_id INT(10)
country_code CHAR(2)
Indexes
geography.countries
country_code CHAR(2)
iso_code CHAR(3)
country_name VARCHAR(45)
currency_code CHAR(3)
continent_code CHAR(2)
population INT(10)
are_in_sq_km INT(10)
capital VARCHAR(30)
Indexes
1
1..*
1
1..*
1
1..*
1
1..*
1
1..*
1
1..*
1
1..*
1
1..*

Summary

- We design databases by specification entities and their characteristics
- Two types of relations:
  - One-to-many
  - Many-to-many
- We visualize relations via E/R diagrams

Table Relations

Questions?

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