

# Data Science Foundations

Master in Big Data Solutions 2017-2018



Liana Napalkova  
liana.napalkova@bts.tech

Ludovico Boratto  
ludovico.boratto@bts.tech

Francisco Gutierrez  
francisco.gutierrez@bts.tech

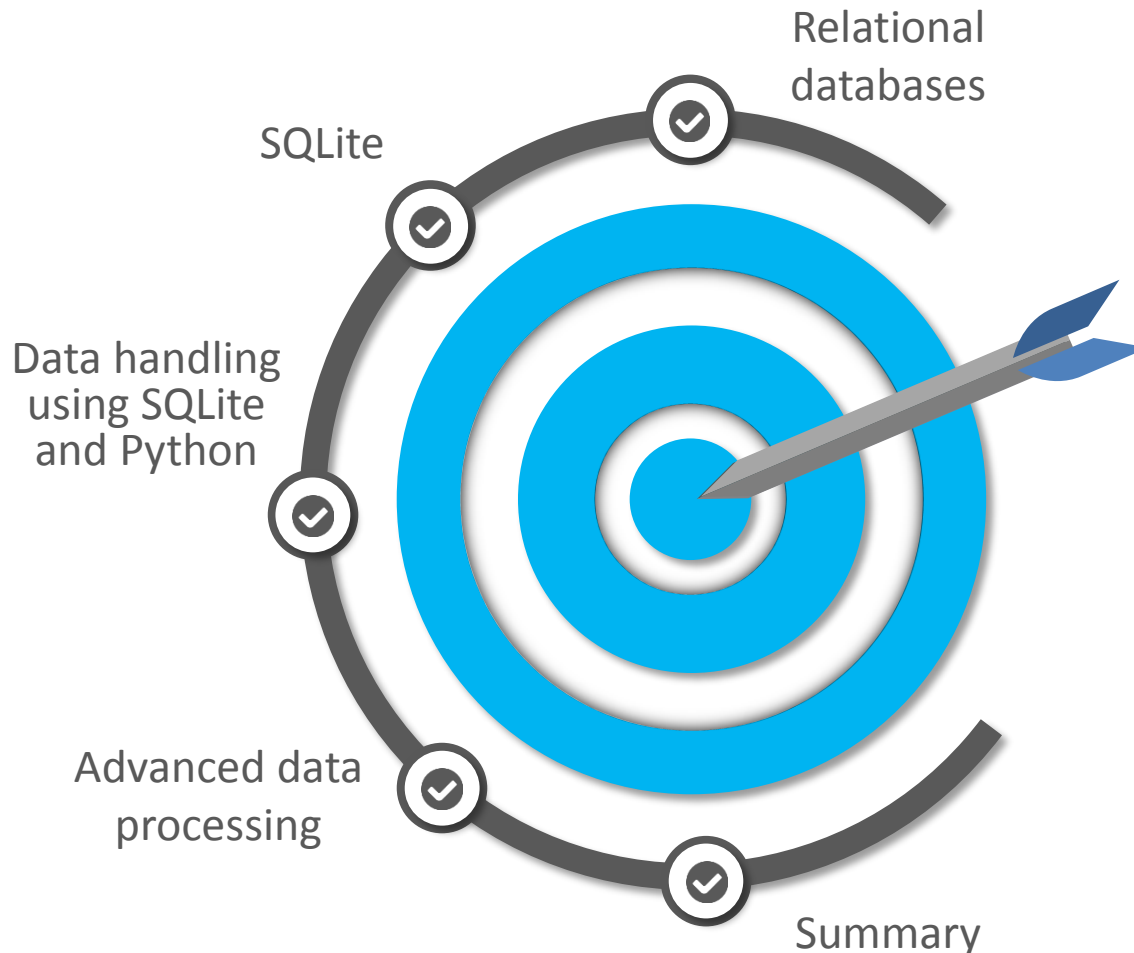
# Today's Objective



What will we learn today?

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

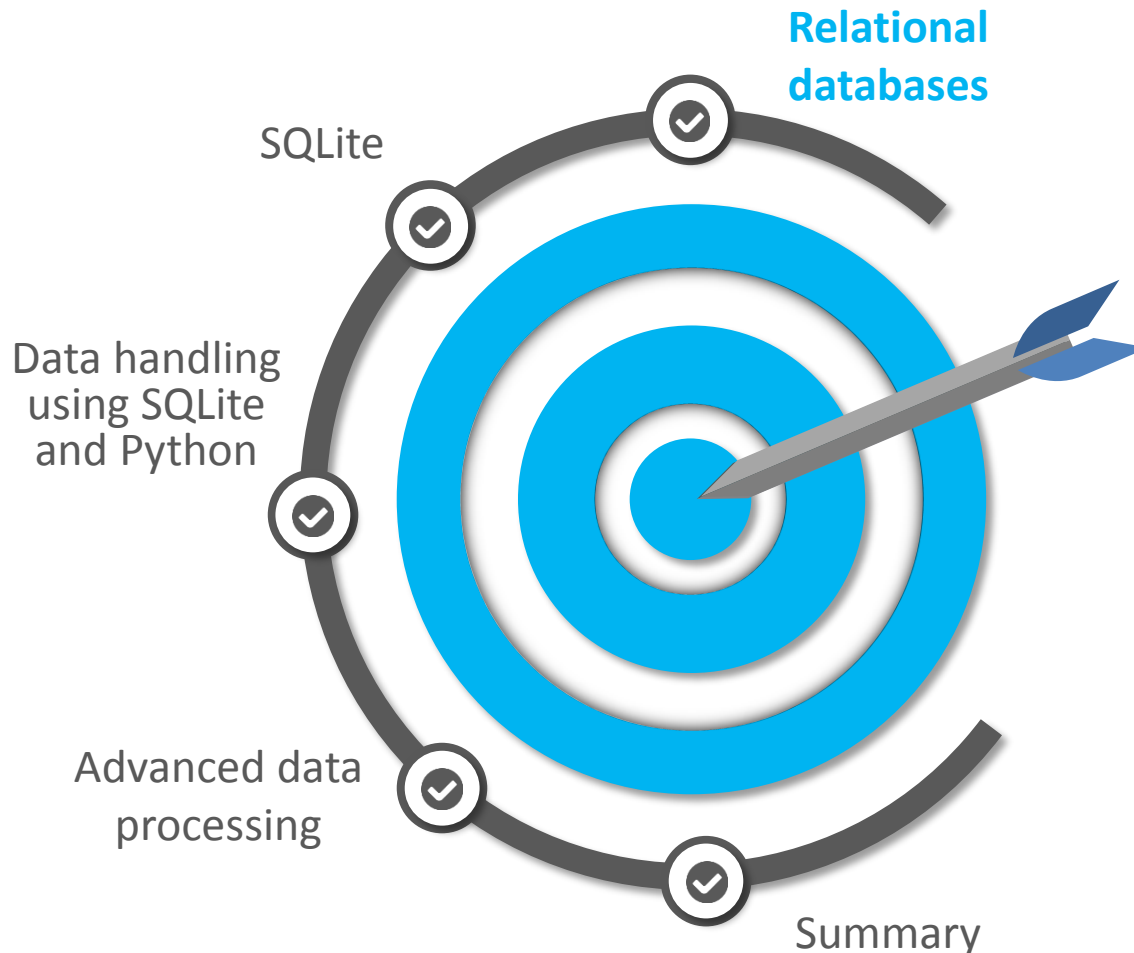
# Contents



## Today's objective

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

# Contents



## Today's objective

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

# Relational databases

- In a real world the data is often stored in relational databases.
- Relational databases store the data as tables (rows and columns).
- The power of the relational database lies in its ability to efficiently retrieve data from those tables using the query language.

# Relational databases

- **Database** - contains a set of tables.
- **Table** - contains tuples and attributes.
- **Tuple (or row)** - a set of fields that generally represents an “object”, for example, a book, a student, etc.
- **Attribute (also column or field)** – a feature that describes the object represented by the row, for example:
  - ✓ The object “book” might have attributes like “title”, “authors”, “number of pages”, etc.
  - ✓ Which are possible attributes of the object “student”?

# Relational databases

## Database “university”

### students

name	surnames	email	country	course
John	Berry	<a href="mailto:jb@uni.edu">jb@uni.edu</a>	UK	1
Bianca	Mendez	<a href="mailto:bm@uni.edu">bm@uni.edu</a>	Venezuela	1
Bruno	Fiadino	<a href="mailto:bf@uni.edu">bf@uni.edu</a>	Italy	2

### courses

Course ID	Course title
1	Course #1
2	Course #2

# Relational databases

**Structured Query Language** is the language we use to issue commands to the database:

- Create a table
- Retrieve some data
- Insert data
- Delete data



# Relational databases

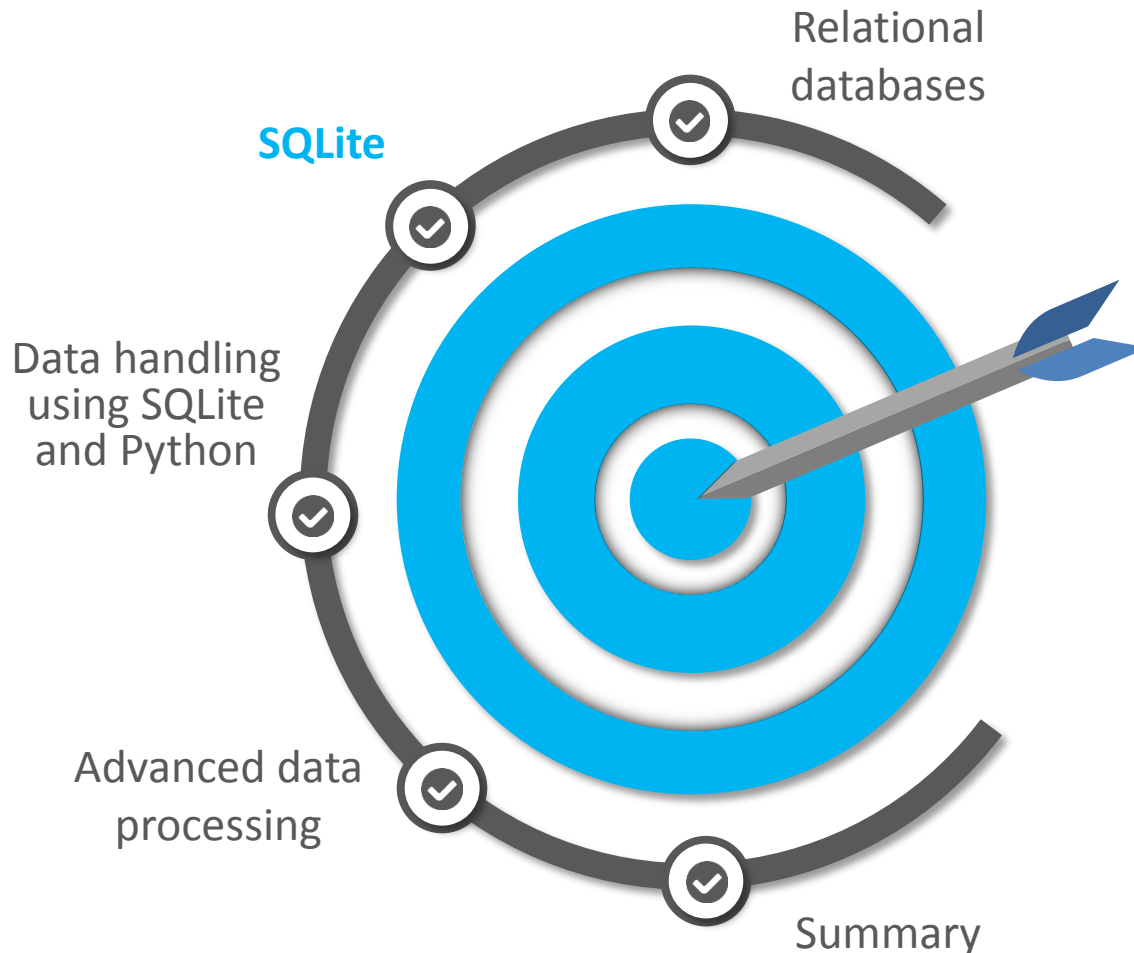
Three Database Management Systems in wide use:

- **Oracle** - Large, commercial, enterprise-scale.
- **MySQL** - Simple but very fast and scalable - commercial open source.
- **SQL Server** – Microsoft's enterprise-scale solution.

Many other smaller projects, free and open source:

- **SQLite**,
- **PostgreSQL**,
- and others.

# Contents



## Today's objective

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

# SQLite

- SQLite is a very popular database - it is free and fast and small.
- SQLite Browser allows us to directly manipulate SQLite files.
- SQLite is embedded in Python and a number of other languages.
- Download link:

<http://sqlitebrowser.org/>

# Relational databases

## Database “university”

### students

s_pk	name	surnames	email	country	c_pk
1	John	Berry	<a href="mailto:jb@uni.edu">jb@uni.edu</a>	UK	1
2	Bianca	Mendez	<a href="mailto:bm@uni.edu">bm@uni.edu</a>	Venezuela	1
3	Bruno	Fiadino	<a href="mailto:bf@uni.edu">bf@uni.edu</a>	Italy	2

### courses

c_pk	title
1	Course #1
2	Course #2

# SQLite

## Start simple

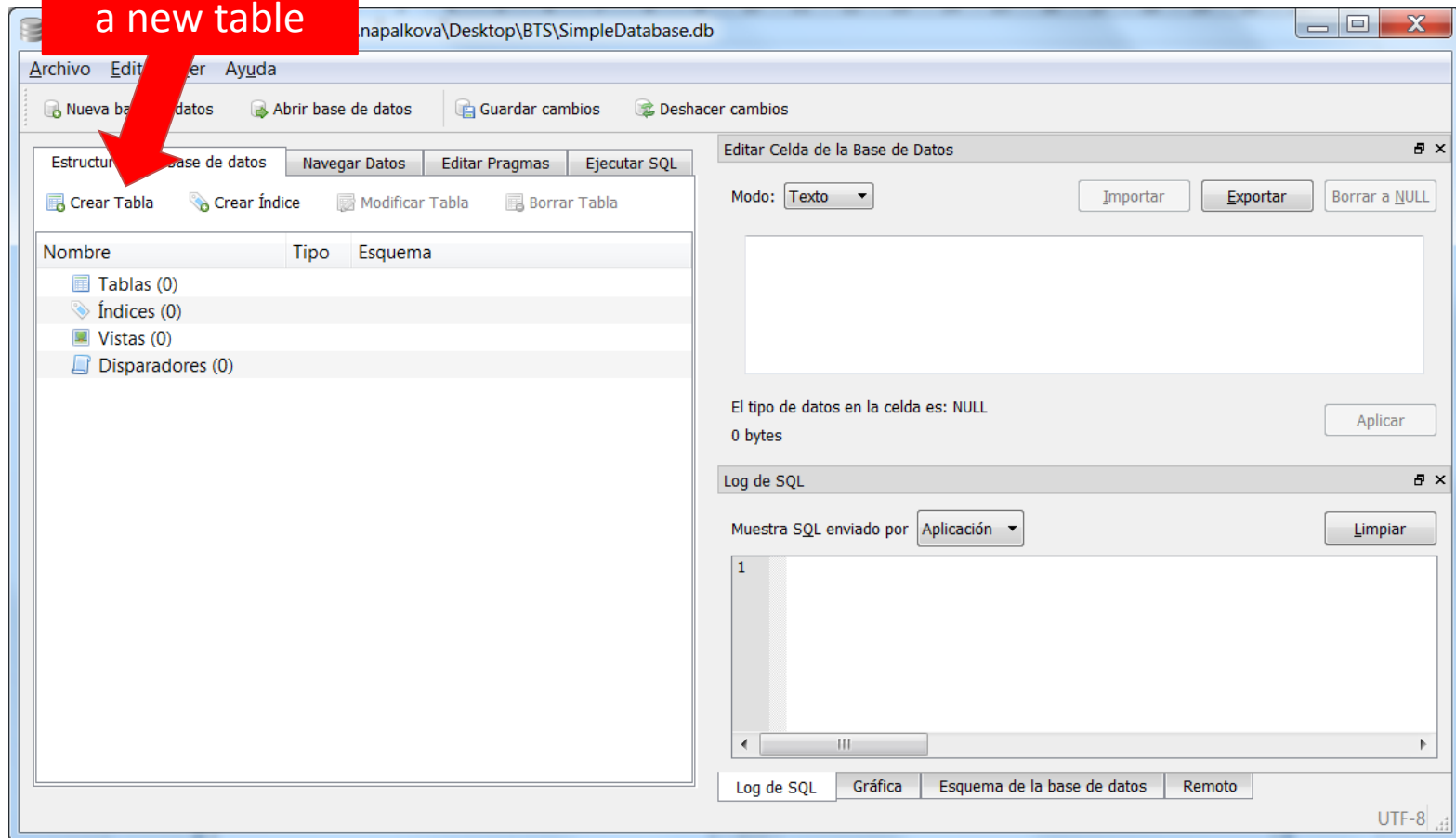
We will do the following exercise:

1. Open SQLite
2. Create a new database and save it in “Session\_3” in your local folder “DataScienceFoundations”
3. Create a new table called “students”:

# SQLite

## Start simple

Click to create  
a new table



# SQLite

## Start simple

1. Set the name  
of a table as  
"students"

2. Create four  
columns

3. This query is  
created automatically

Editar la definición de la tabla

Tabla  
**students**

▼ Avanzado

Campos

Añadir campo Eliminar campo Mover campo hacia arriba Mover campo hacia abajo

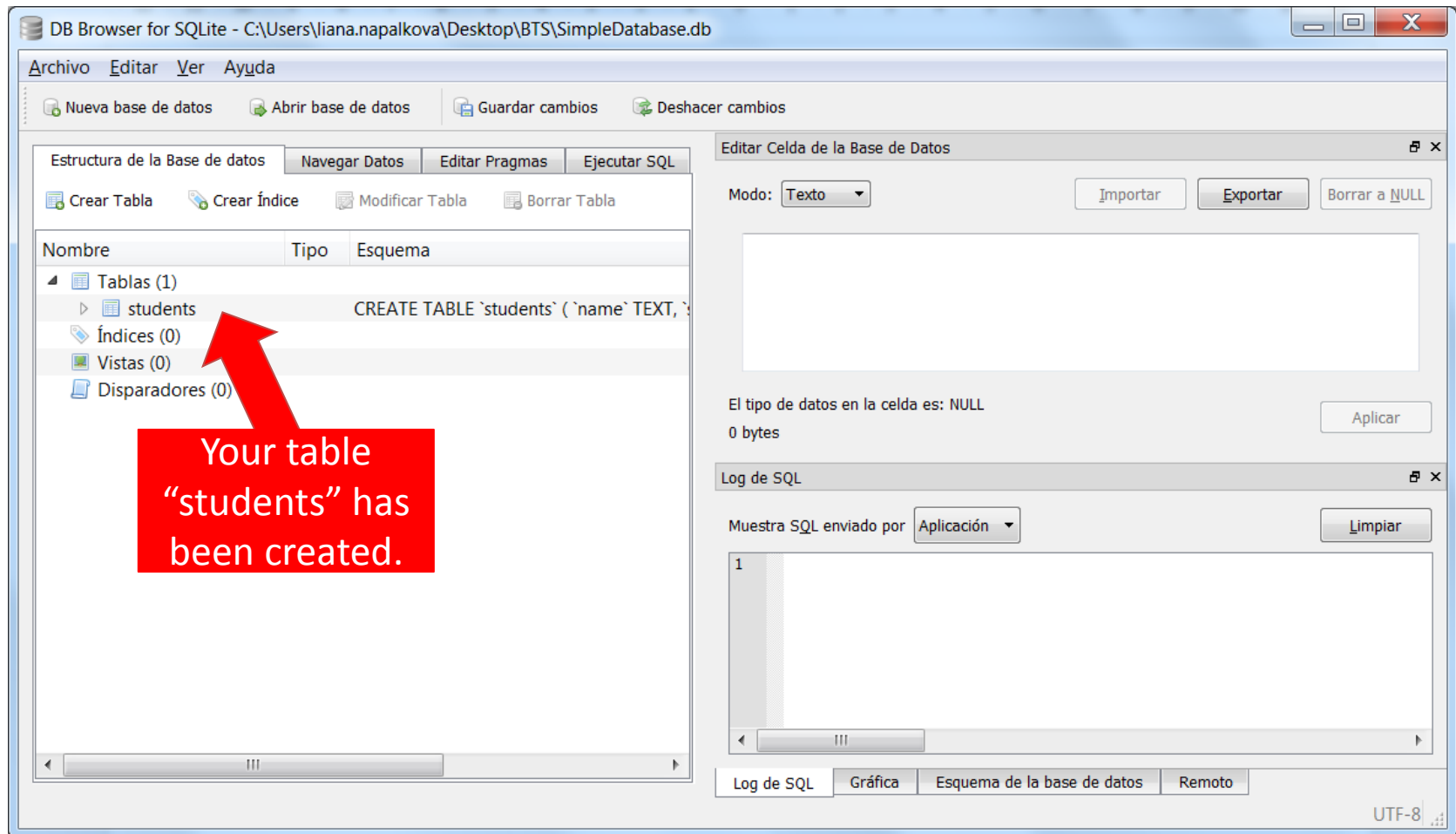
Nombre	Tipo	No	PK	AI	U	Por defecto	Check
name	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
surnames	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
email	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
country	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

```
1 CREATE TABLE `students` (  
2   `name` TEXT,  
3   `surnames` TEXT,  
4   `email` TEXT,  
5   `country` TEXT  
6 );
```

OK Cancel

# SQLite

## Start simple





# SQLite

## Start simple

Now we will add some data to the table “students”.

<b>name</b>	<b>surnames</b>	<b>email</b>	<b>country</b>
John	Berry	<a href="mailto:jb@uni.edu">jb@uni.edu</a>	UK
Bianca	Mendez	<a href="mailto:bm@uni.edu">bm@uni.edu</a>	Venezuela
Bruno	Fiadino	<a href="mailto:bf@uni.edu">bf@uni.edu</a>	Italy

# SQLite

## Start simple: SQL INSERT

The INSERT statement allows adding a new row into a table:

```
INSERT INTO students (name, surnames, email,  
country) VALUES ('john', 'berry', 'jb@uni.edu',  
'UK')
```

# SQLite

## Start simple: SQL INSERT

The screenshot shows the DB Browser for SQLite interface with the following components and annotations:

- 1. Open the tab "Execute SQL"**: A red arrow points to the "Ejecutar SQL" tab in the top menu bar.
- 2. Write SQL query**: A red arrow points to the SQL editor area where the query is typed.
- 3. Execute query**: A red arrow points to the "Execute SQL" button (represented by a play icon) in the toolbar.
- 4. See the result**: A red arrow points to the "Consulta ejecutada con éxito" message in the bottom left pane.

The SQL query entered in the editor is:

```
1 insert into students (name,surnames,email,country)
```

The successful execution message in the bottom left pane reads:

```
Consulta ejecutada con éxito: insert into
students (name,surnames,email,country) values
('john','berry','jb@uni.edu','UK') (tardó 2ms, 1
líneas afectadas)
```

The bottom right pane shows the database schema for the 'students' table:

```
9 CREATE TABLE `students` (
10   `name` TEXT,
11   `surnames` TEXT,
12   `email` TEXT,
13   `country` TEXT
14 );
15 SELECT type,name,sql,tbl_name,'0' AS temp FROM sqlite_m
16
```

The bottom status bar includes tabs for "Log de SQL", "Gráfica", "Esquema de la base de datos", and "Remoto", along with a "UTF-8" encoding indicator.

# SQLite

## Start simple: SQL INSERT

DB Browser for SQLite - C:\Users\Iana.napalkova\De

Archivo Editar Ver Ayuda

Nueva base de datos Abrir base de datos

Estructura de la Base de datos Navegar Datos Editar Pragmas Ejecutar SQL

Tabla: students Nuevo registro Borrar registro

	name	surnames	email	country
	Filtro	Filtro	Filtro	Filtro
1	john	berry	jb@uni.edu	UK

El tipo de datos en la celda es: NULL  
0 bytes

Log de SQL

Muestra SQL enviado por Aplicación

```
18 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `students`
19 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` A
20 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `students`
21 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` A
22 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `students`
23 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` A
24
```

Log de SQL Gráfica Esquema de la base de datos Remoto

UTF-8

Open the tab

# SQLite

## Start simple: SQL INSERT

The screenshot shows the DB Browser for SQLite interface. The main window displays a table named 'students' with the following data:

	name	surnames	email	country
1	John	Berry	jb@uni.edu	UK

A red arrow points to the 'John' entry in the 'name' column, with a text box stating: "We should change 'john' by 'John' and 'berry' by 'Berry'".

The right-hand pane shows the 'Editar Celda de la Base de Datos' (Edit Cell) dialog. The 'Modo' (Mode) is set to 'Texto' (Text). The text 'Berry' is entered in the input field. A red arrow points from the text 'Use this console' to the input field.

Below the input field, the 'Log de SQL' (SQL Log) pane shows the following SQL commands:

```
28 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `students`
29 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` A
30 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `students`
31 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` A
32 UPDATE `students` SET `name`=? WHERE `_rowid_`='1';
33 UPDATE `students` SET `surnames`=? WHERE `_rowid_`='1';
34
```

The bottom status bar indicates the encoding is UTF-8.

# SQLite

## Start simple: SQL INSERT

Please add the other two rows into the table “students”.

name	surnames	email	country
John	Berry	<a href="mailto:jb@uni.edu">jb@uni.edu</a>	UK
Bianca	Mendez	<a href="mailto:bm@uni.edu">bm@uni.edu</a>	Venezuela
Bruno	Fiadino	<a href="mailto:bf@uni.edu">bf@uni.edu</a>	Italy

```
INSERT INTO students (name, surnames, email, country)
VALUES (write the values of columns here)
```

# SQLite

## Start simple: SQL UPDATE

The UPDATE statement allows modifying a field with a where clause:

```
UPDATE    students    SET    email='jbb@uni.edu'    WHERE  
name='John'  AND  surnames='Berry'
```

# SQLite

## Start simple: SQL UPDATE

The screenshot shows the DB Browser for SQLite application. The main window displays the SQL editor with the following query:

```
1 update students set email='jbb@uni.edu' where name='John' and surnames='Berry'
```

Below the query, the execution result is shown:

```
Consulta ejecutada con éxito: update students set email='jbb@uni.edu' where name='John' and surnames='Berry' (tardó 0ms, 1 líneas afectadas)
```

A red arrow points from the text "Please check that you see '1 line affected'" to the "1 líneas afectadas" part of the result.

The application also shows the "Editar Celda de la Base de Datos" dialog box, which is currently empty. The "Log de SQL" panel at the bottom right shows the following log entries:

```
47 PRAGMA synchronous
48 PRAGMA temp_store
49 PRAGMA user_version
50 PRAGMA wal_autocheckpoint
51
```



# SQLite

## Start simple: SQL SELECT

- The SELECT statement retrieves a group of records - you can either retrieve all the records or a subset of the records with a WHERE clause
- Please execute the following SELECT statements one by one and say which results do you see:

✓ **SELECT \* FROM students**

✓ **SELECT name, surnames FROM students**

✓ **SELECT \* FROM students WHERE country='UK'**

# SQLite

## Start simple: SQL DELETE

The DELETE statement eliminates a row in a table based on a selection criteria:

```
DELETE FROM students WHERE name='John'
```

# SQLite

## Keys

Which types of keys the tables can have?

### Primary key

Generally an integer auto-increment field

### Logical key

What the outside world uses for lookup

### Foreign key

An integer key pointing to a row in another table

# SQLite

## Keys

### Database “university”

#### students

s_pk	name	surnames	email	country	c_pk
1	John	Berry	<a href="mailto:jb@uni.edu">jb@uni.edu</a>	UK	1
2	Bianca	Mendez	<a href="mailto:bm@uni.edu">bm@uni.edu</a>	Venezuela	1
3	Bruno	Fiadino	<a href="mailto:bf@uni.edu">bf@uni.edu</a>	Italy	2

#### courses

c_pk	title
1	Course #1
2	Course #2

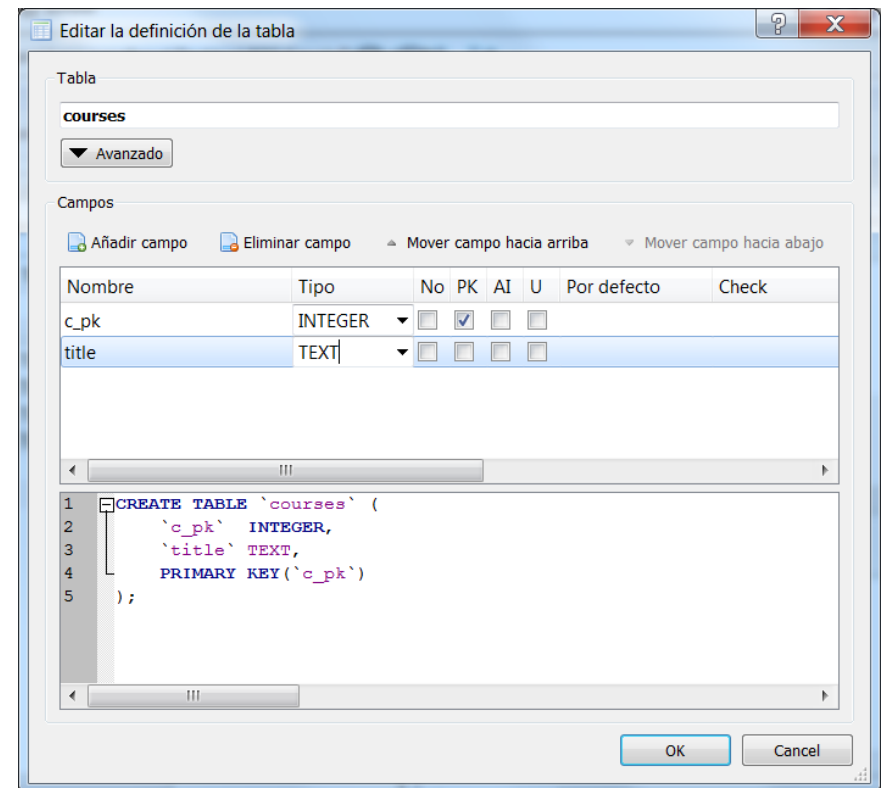
# SQLite

## Keys

Let's first create a new table "courses":

c_pk	title
1	Course #1
2	Course #2

Please notice that "c\_pk" is marked as a primary key (PK).



# SQLite

## Keys

If everything is correct, you will see two rows in the table “courses”.

The screenshot shows the DB Browser for SQLite application. The 'Estructura de la Base de datos' tab is active, displaying the 'courses' table. The table has two columns: 'c\_pk' and 'title'. The data is as follows:

c_pk	title
1	course 1
2	course 2

The table is highlighted with a red rectangle. The 'Log de SQL' panel on the right shows a query that counts the number of rows in the 'courses' table, returning 2.

```
72 SELECT COUNT(*) FROM (SELECT `rowid`,`*` FROM `students`  
73 SELECT `rowid`,`*` FROM `students` ORDER BY `rowid` AS  
74 SELECT COUNT(*) FROM (SELECT `rowid`,`*` FROM `courses`  
75 SELECT `rowid`,`*` FROM `courses` ORDER BY `rowid` AS  
76 SELECT COUNT(*) FROM (SELECT `rowid`,`*` FROM `courses`  
77 SELECT `rowid`,`*` FROM `courses` ORDER BY `rowid` AS  
78
```

# SQLite

## Keys

Now modify the table “students” in order to add an auto-incremented primary key “s\_pk” and a new field “c\_pk”.

The field “c\_pk” will be used as a foreign key to link the table “students” with the table “courses”.

Editar la definición de la tabla

Tabla

students

▼ Avanzado

Campos

Nombre	Tipo	No	PK	AI	U	Por defecto	Check
s_pk	INTEGER	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
name	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
surnames	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
email	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
country	TEXT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
c_pk	INTEGER	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

```

1 CREATE TABLE `students` (
2   `s_pk` INTEGER PRIMARY KEY AUTOINCREMENT,
3   `name` TEXT,
4   `surnames` TEXT,
5   `email` TEXT,
6   `country` TEXT,
7   `c_pk` INTEGER
8 )
  
```

OK Cancel

# SQLite

## Keys

Please modify the values of the foreign key “c\_pk” in the table “students” so that it looks as follows:

**students**

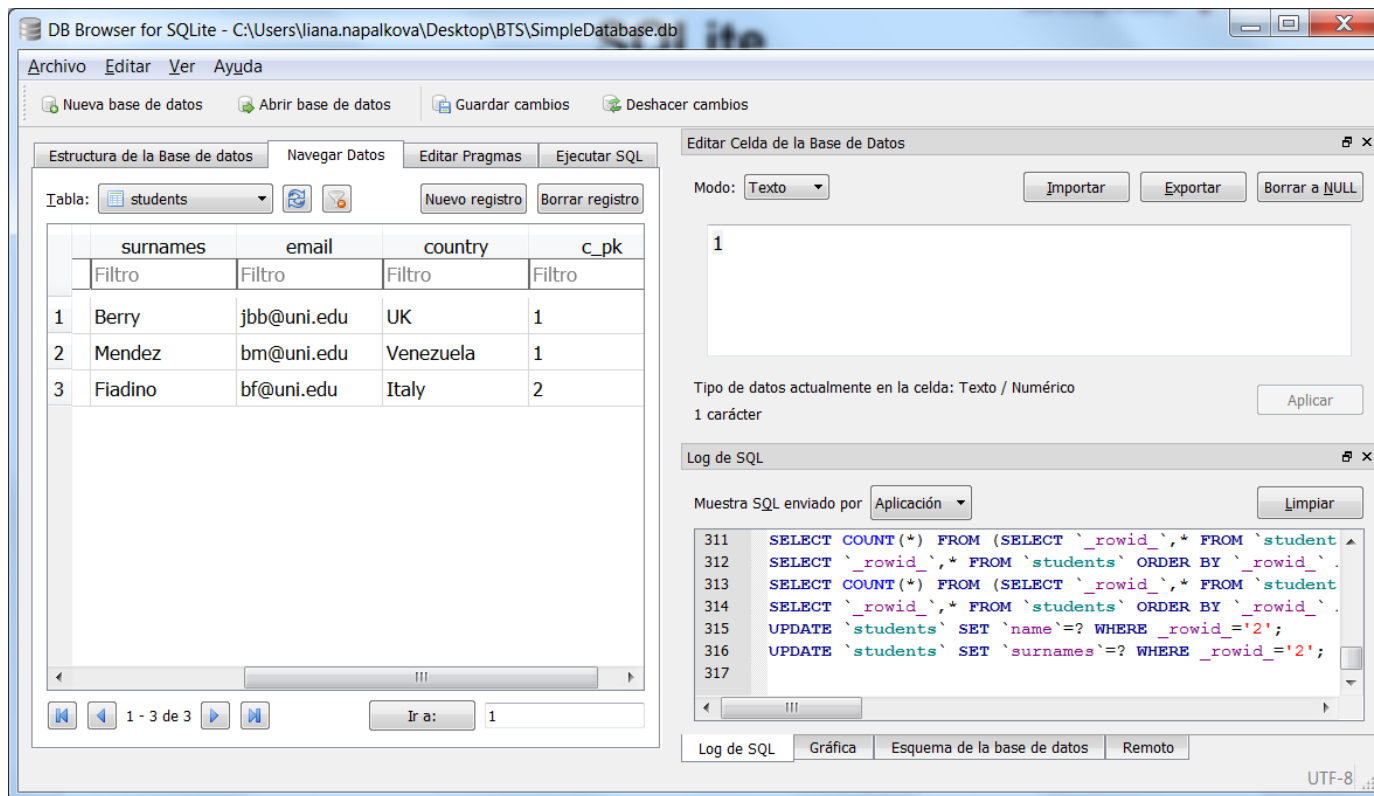
s_pk	name	surnames	email	country	c_pk
1	John	Berry	<a href="mailto:jb@uni.edu">jb@uni.edu</a>	UK	1
2	Bianca	Mendez	<a href="mailto:bm@uni.edu">bm@uni.edu</a>	Venezuela	1
3	Bruno	Fiadino	<a href="mailto:bf@uni.edu">bf@uni.edu</a>	Italy	2



# SQLite

## Keys

If everything is correct, your table “students” should now look like this:



The screenshot shows the DB Browser for SQLite application. The main window displays the 'students' table structure and data. The table has four columns: surnames, email, country, and c\_pk. The data is as follows:

	surnames	email	country	c_pk
1	Berry	jbb@uni.edu	UK	1
2	Mendez	bm@uni.edu	Venezuela	1
3	Fiadino	bf@uni.edu	Italy	2

The right panel shows the 'Editar Celda de la Base de Datos' window, which is currently in 'Texto' mode. The 'Log de SQL' panel shows the following SQL queries:

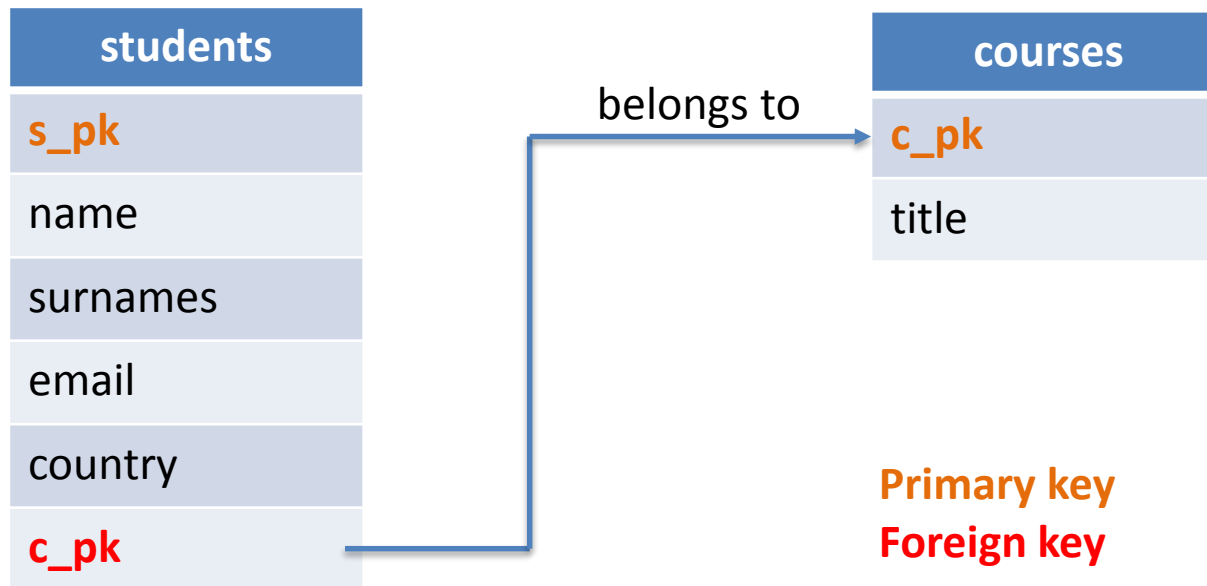
```

311 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `student
312 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` .
313 SELECT COUNT(*) FROM (SELECT `_rowid_`,* FROM `student
314 SELECT `_rowid_`,* FROM `students` ORDER BY `_rowid_` .
315 UPDATE `students` SET `name`=? WHERE `_rowid_`='2';
316 UPDATE `students` SET `surnames`=? WHERE `_rowid_`='2';
317
  
```

# SQLite

## Relationship building

- We have just created the following relationships between the tables “students” and “courses”:

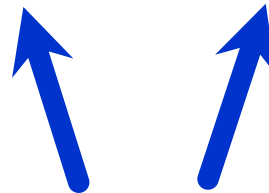


# SQLite

## SQL JOIN

- The JOIN operation links across several tables as part of a select operation.
- You must tell the **JOIN** how to use the keys that make the connection between the tables using an **ON clause**.

```
SELECT students.name, courses.title FROM students JOIN courses ON students.c_pk = courses.c_pk
```



What we want to see

The tables that  
hold the data

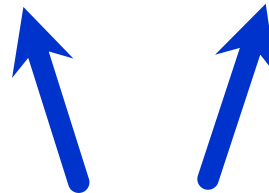
How the tables  
are linked

# SQLite

## SQL JOIN

- Please execute this statement yourself and tell the result that you see.

```
SELECT students.name, courses.title FROM students JOIN courses ON students.c_pk = courses.c_pk
```



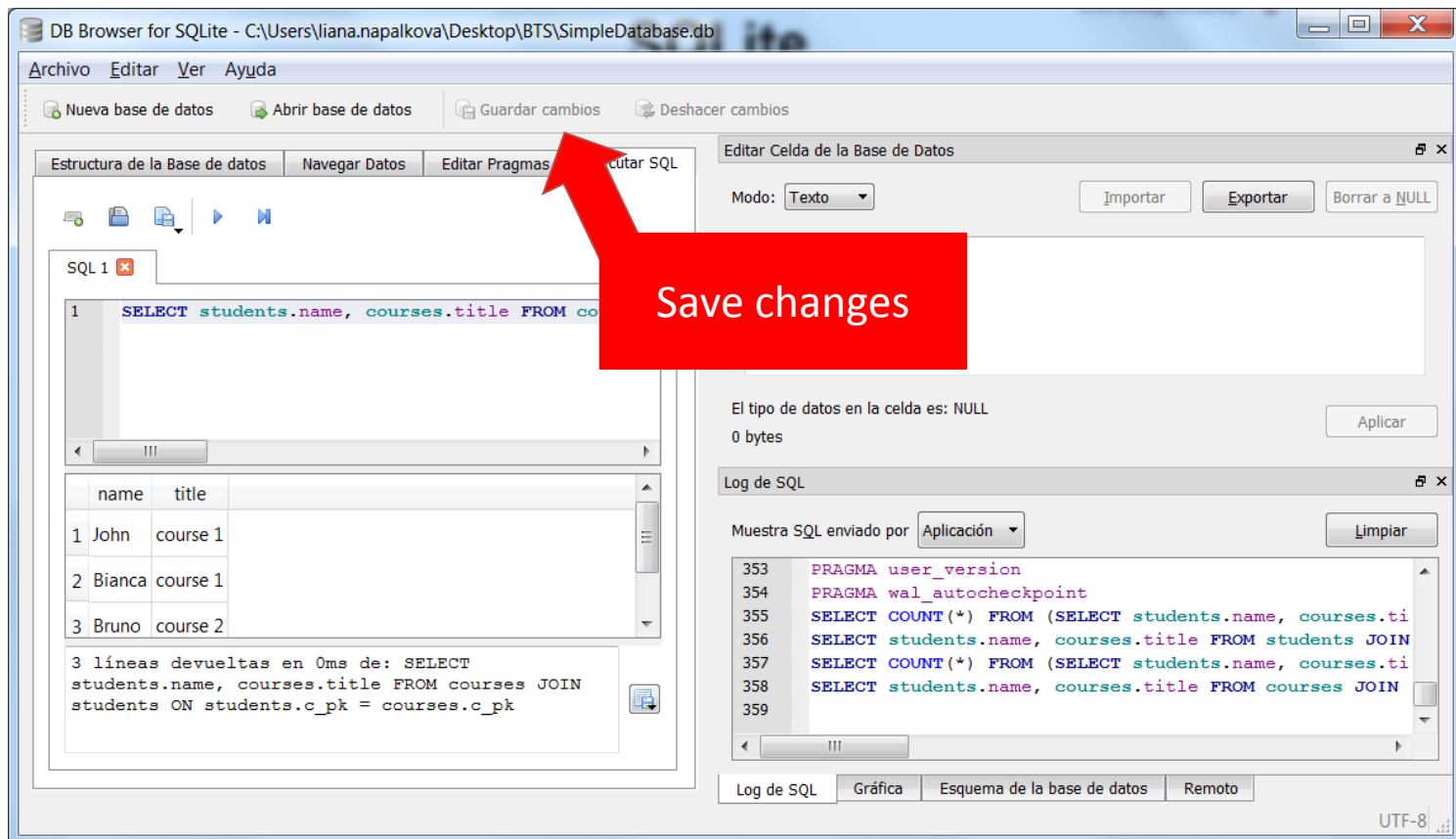
What we want to see

The tables that  
hold the data

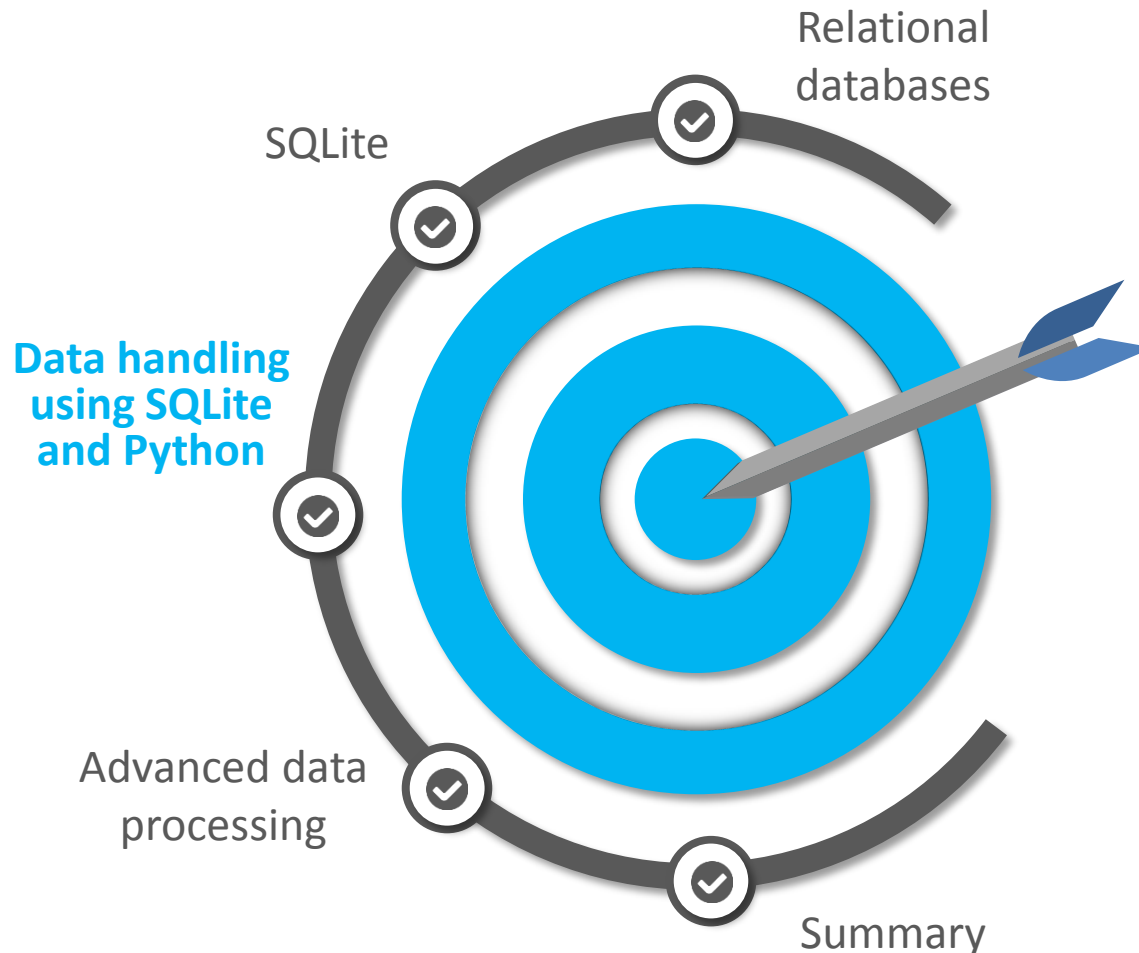
How the tables  
are linked

# SQLite

- Click on the button “Save” in order to save your database and tables.



# Contents



## Today's objective

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

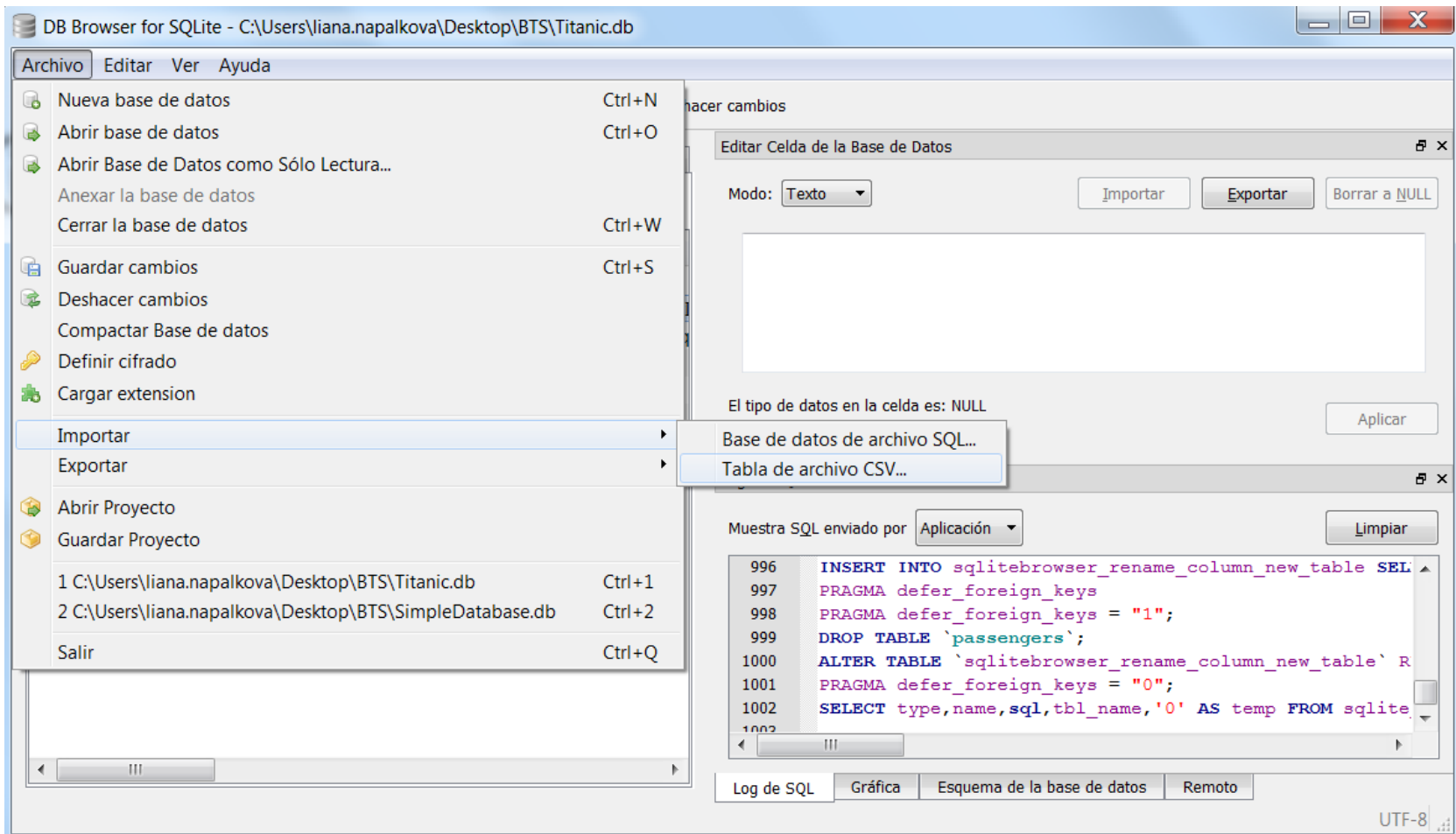
# Data handling using SQLite and Python

## Loading data into SQLite database

- Now we will learn how to load the data from CSV file into SQLite database.
- First of all, please create a new database called “Titanic” and save it in “Session\_3” in your local folder “DataScienceFoundations”.
- In SQLite go to File->Import->CSV

# Data handling using SQLite and Python

## Loading data into SQLite database





# Data handling using SQLite and Python

## Loading data into SQLite database

Importar archivo CSV

Nombre de la tabla: passengers

Nombres de columna en la primera línea: ☒

Separador de campos: ,

Entrecorillado: "

Codificado: UTF-8

¿Recortar campos?: ☒

	PassengerId	Survived	Pclass	Name	Sex	
1	1	0	3	Braund, Mr. Ow...	male	22
2	2	1	1	Cumings, Mrs. J...	female	38
3	3	1	3	Heikkinen, Miss....	female	26
4	4	1	1	Futrelle, Mrs. Ja...	female	35
5	5	0	3	Allen, Mr. Willia...	male	35

OK Cancel

# Data handling using SQLite and Python

## Loading data into SQLite database

- We have just created a new database called “Titanic” and loaded titanic dataset into the table “passengers”.

The screenshot shows the DB Browser for SQLite application. The main window displays the 'passengers' table structure and data. The table has four columns: PassengerId, Survived, Pclass, and Name. The data is shown in a grid with 10 rows. The right panel shows the 'Editar Celda de la Base de Datos' window, which is currently empty. The bottom panel shows the 'Log de SQL' window, which contains a list of SQL queries executed, including a SELECT statement that counts the number of passengers who survived.

DB Browser for SQLite - C:\Users\iana.napalkova\Desktop\BTS\Titanic.db

Archivo Editar Ver Ayuda

Nueva base de datos Abrir base de datos Guardar cambios Deshacer cambios

Estructura de la Base de datos Navegar Datos Editar Pragmas Ejecutar SQL

Tabla: **passengers** Nuevo registro Borrar registro

	PassengerId	Survived	Pclass	Name
	Filtro	Filtro	Filtro	Filtro
1	1	0	3	Braund, M
2	2	1	1	Cumings,
3	3	1	3	Heikkinen
4	4	1	1	Futrelle, L
5	5	0	3	Allen, Mr.
6	6	0	3	Moran, M
7	7	0	1	McCarthy
8	8	0	3	Palsson, L
9	9	1	3	Johnson,
10	10	1	2	Nasser, M

1 - 11 de 891 Ir a: 1

Editar Celda de la Base de Datos

Modo: Texto Importar Exportar Borrar a NULL

El tipo de datos en la celda es: NULL  
0 bytes Aplicar

Log de SQL

Muestra SQL enviado por Aplicación Limpiar

```

1154 SELECT COUNT(*) FROM (select count(*) from passengers
1155 select count(*) from passengers where Survived="1" LI
1156 SELECT COUNT(*) FROM (SELECT `_rowid`,`*` FROM `passen
1157 SELECT `_rowid`,`*` FROM `passengers` ORDER BY `_rowid`
1158 SELECT COUNT(*) FROM (SELECT `_rowid`,`*` FROM `passen
1159 SELECT `_rowid`,`*` FROM `passengers` ORDER BY `_rowid`
1160

```

Log de SQL Gráfica Esquema de la base de datos Remoto

UTF-8

# Data handling using SQLite and Python

## Loading data into SQLite database

- By default all column types are TEXT.
- Please modify them as follows and save the database.

PassengerId	-> Integer
Survived	-> Integer
Pclass	-> Integer
Name	-> Text
Sex	-> Text
Age	-> Real
SibSp	-> Integer
Parch	-> Integer
Ticket	-> Text
Fare	-> Real
Cabin	-> Text
Embarked	-> Text

# Data handling using SQLite and Python

## Loading data into SQLite database

- Execute the query to be sure that everything is correct:

```
select count(*) from passengers
```

```
select count(*) from passengers where Survived=1
```

```
select count(*) from passengers where Survived=0
```

# Data handling using SQLite and Python

## Retrieving data from SQLite database

- Now we will retrieve the data from our “Titanic” database using Python and Pandas.
- Synchronize your folder “BTS\_MasterInBigData” with the remote repository “BTS\_MasterInBigData”:

[https://github.com/LianaNapalkova/BTS\\_MasterInBigData.git](https://github.com/LianaNapalkova/BTS_MasterInBigData.git)

- Go to the folder “Session\_3” and import the file “1\_retrieve\_data\_from\_SQLite\_database.ipynb” into your Jupyter Notebook.

# Data handling using SQLite and Python

## Retrieving data from SQLite database

To retrieve the data from DB, we execute the following steps:

1. Establish a connection to the SQLite database by creating a Connection object.
2. Create a Cursor object using the cursor method of the Connection object.
3. Execute the SELECT statement.
4. Call the fetchall() method of the cursor object to fetch the data.
5. Loop the cursor and process each row individually.

# Data handling using SQLite and Python

## Retrieving data from SQLite database

- Change the `database` by the path to `Titanic.db` on your local file system:

```
database = "C:\\Users\\liana.napalkova\\Desktop\\BTS\\Titanic.db"
```

- Execute the code “`1_retrieve_data_from_SQLite_database.ipynb`” in your Jupyter Notebook.
- Which results do you get?

# Data handling using SQLite and Python

## Retrieving data from SQLite database

- Now let's retrieve data from the database "Titanic" using Pandas.
- Go to the folder "Session\_3" and import the file "2\_retrieve\_data\_from\_SQLite\_database\_pandas.ipynb" into your Jupyter Notebook.
- Change the database by the path to `Titanic.db` on your local file system:

```
database = "C:\\Users\\liana.napalkova\\Desktop\\BTS\\Titanic.db"
```

- Execute the code.
- Push your Jupyter Notebook and database file into the folder "Session\_3" of your repository "DataScienceFoundations".

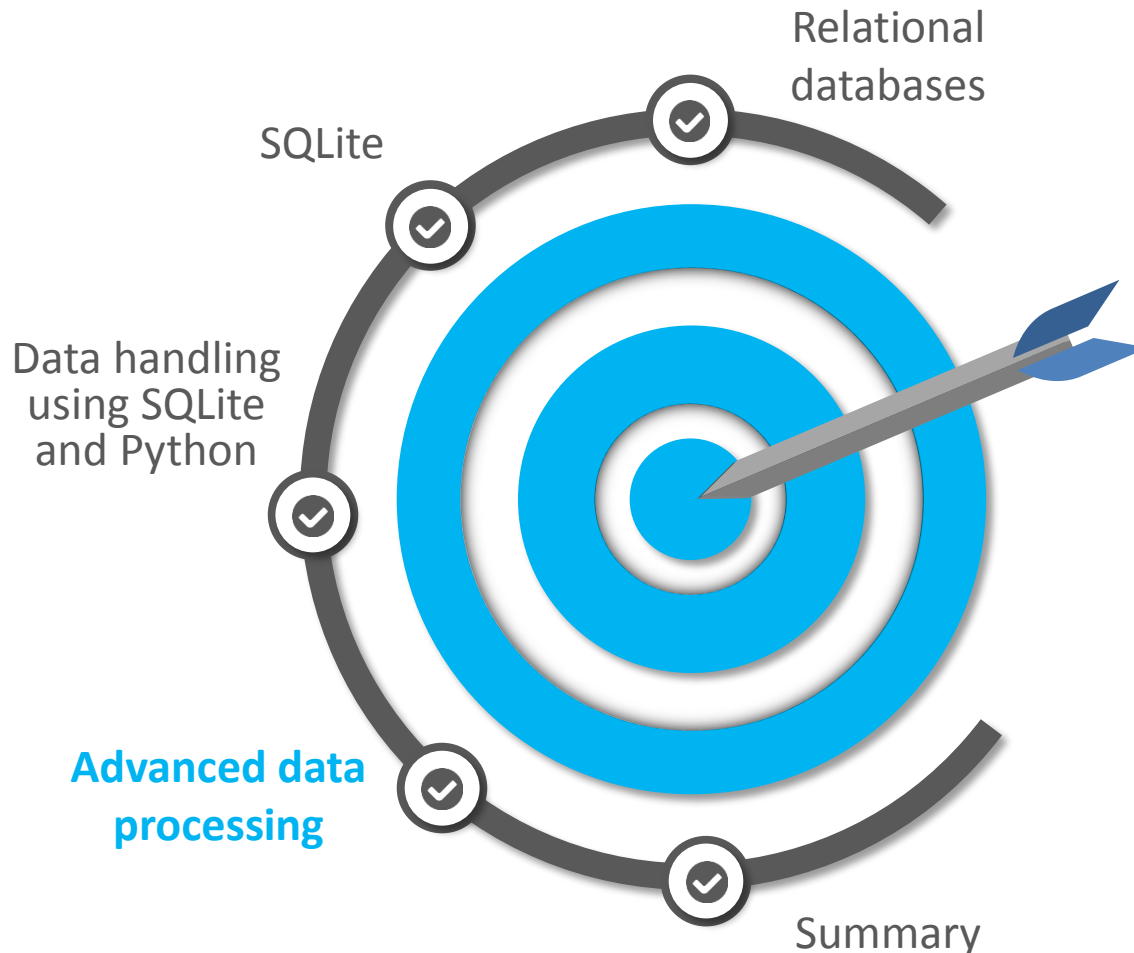


# Data handling using SQLite and Python

## Task

- Create a new database “BikeSharing” for storing bike sharing data (see Session 2 to find the dataset).
- Load bike sharing data into your database.
- Create a new Jupyter Notebook and write a code for retrieving data from your database into Pandas DataFrame.
- Push your Jupyter Notebook and database file into the folder “Session\_3” of your repository “DataScienceFoundations”.

# Contents



## Today's objective

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

# Advanced processing of data

- Open any notebook that you used to analyze Titanic dataset.
- Execute the script in order to load the Titanic dataset into Pandas DataFrame.
- Now we will learn how to do the advanced data processing.

# Advanced processing of data

- Take a look at the column “Name”.
- It has entries like “Braund, Mr. Owen Harris”, “Heikkinen, Miss. Laina”, etc.
- What can you see?

# Advanced processing of data

- Take a look at the column “Name”.
- It has entries like “Braund, Mr. Owen Harris”, “Heikkinen, Miss. Laina”, etc.
- What can you see?
- We can see that this column contains information about the title of a person: Miss, Mrs, Mr, Master, and others.
- How can we create a new column that would contain these values?

# Advanced processing of data

```
import re

# Define function to extract titles from passenger names
def get_title(name):
    title_search = re.search(' ([A-Za-z]+)\.', name)
    # If the title exists, extract and return it.
    if title_search:
        return title_search.group(1)
    return ""

# Create a new feature Title
df['Title'] = df['Name'].apply(get_title)
```

Which result do you get by running this code?:

```
df['Title'].unique()
```

# Advanced processing of data

- The replace function allows substituting values by another values.
- For example, it is possible to substitute a set of values by a single value as follows:

```
# Replace all rare titles by Rare
df['Title'] = df['Title'].replace(['Lady', 'Countess', 'Capt',
'Col', 'Don', 'Dr', 'Major', 'Rev', 'Sir', 'Jonkheer', 'Dona'],
'Reare')
```

- It is also possible to substitute one value by another value:

```
# Make other replacements
df['Title'] = df['Title'].replace('Mlle', 'Miss')
df['Title'] = df['Title'].replace('Ms', 'Miss')
df['Title'] = df['Title'].replace('Mme', 'Mrs')
```

# Advanced processing of data

- Another mapping approach is to use the **loc** function as follows:

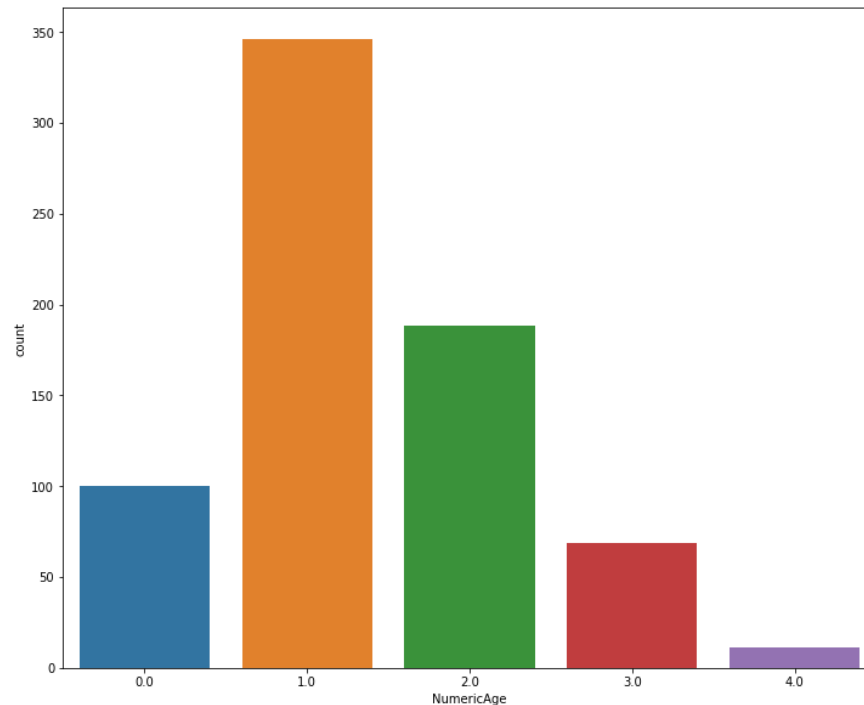
```
df.loc[df['Age'] <= 16, 'NumericAge'] = 0  
df.loc[(df['Age'] > 16) & (df['Age'] <= 32), 'NumericAge'] = 1
```

- Please finish the mapping for all age ranges.
- Please create a counterplot for “NumericAge”.



# Advanced processing of data

```
df.loc[df['Age'] <= 16, 'NumericAge'] = 0  
df.loc[(df['Age'] > 16) & (df['Age'] <= 32), 'NumericAge'] = 1  
df.loc[(df['Age'] > 32) & (df['Age'] <= 48), 'NumericAge'] = 2  
df.loc[(df['Age'] > 48) & (df['Age'] <= 64), 'NumericAge'] = 3  
df.loc[df['Age'] > 64, 'NumericAge'] = 4
```



# Advanced processing of data

- There is another way to convert a numerical variable into a **categorical variable**.

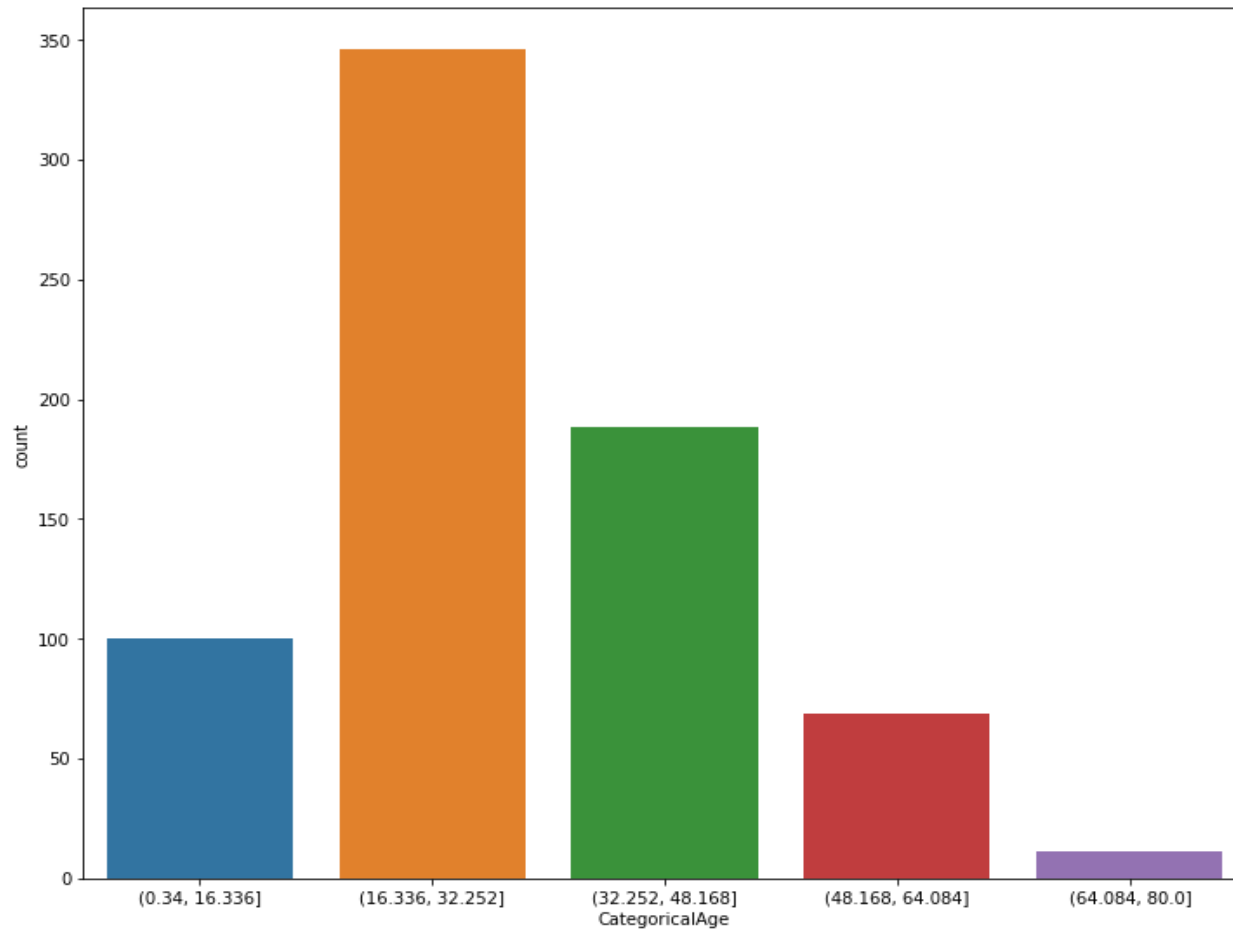
- Run this code:

```
df['CategoricalAge'] = pd.cut(df['Age'], 5)
```

- Create a counterplot for “CategoricalAge”.
- Which age group is the most frequent among the passengers of Titanic?

# Advanced processing of data

```
: plt.figure(figsize=[12,10])  
sns.countplot(df['CategoricalAge'])  
plt.show()
```



# Advanced processing of data

- We can use the function “apply” in order to run a user-defined function row-wise or column-wise.
- For example, let’s create a new feature “Person” that has the following unique values: “female”, “male”, “child”.

```
def get_person(passenger):  
    age,sex = passenger  
    return 'child' if age < 16 else sex  
  
df['Person'] = df[['Age','Sex']].apply(get_person,axis=1)
```

# Advanced processing of data

- Let's imagine that you should create a prediction model (a simple regression model) for predicting “Survived” based on features of a passenger.
- To be able to create the prediction model, all your data should be pre-processed. For example, to apply the regression model, all non-numeric values should be converted into numeric values:
- You can do it using **mapping** - the function “map” allows mapping values to another values, for example:

```
df['Sex'] = df['Sex'].map( {'female': 0, 'male': 1} ).astype(int)
```

```
title_mapping = {"Mr": 1, "Miss": 2, "Mrs": 3, "Master": 4, "Rare": 5}  
df['Title'] = df['Title'].map(title_mapping)  
df['Title'] = df['Title'].fillna(0)
```

# Advanced processing of data

- Finally, we will learn the function **groupby**.
- It is used for grouping the data by column names.
- For example, let's group the data by "Person" and estimate the average value of "Survived" for each group.

```
df[["Person", "Survived"]].groupby(['Person'], as_index=False).mean()
```

	Person	Survived
0	child	0.590361
1	female	0.756458
2	male	0.163873

- Create a barplot to visualize this data.

# Advanced processing of data

- What else can you do using groupby?
- You can group by multiple columns and apply multiple aggregations, e.g. “sum”, “mean”, “min”, “max”.

```
df.groupby(df.index_col).agg({'Age': 'mean',  
                             'Survived': 'sum'})[['Age', 'Survived']]  
    .reset_index()
```

	Person	Embarked	Age	Survived
0	child	C	8.245556	14
1	child	Q	7.200000	1
2	child	S	5.737500	34
3	female	C	33.750000	53
4	female	Q	25.136364	26
5	female	S	31.716561	124
6	male	C	34.960938	26
7	male	Q	39.500000	3
8	male	S	32.608309	59

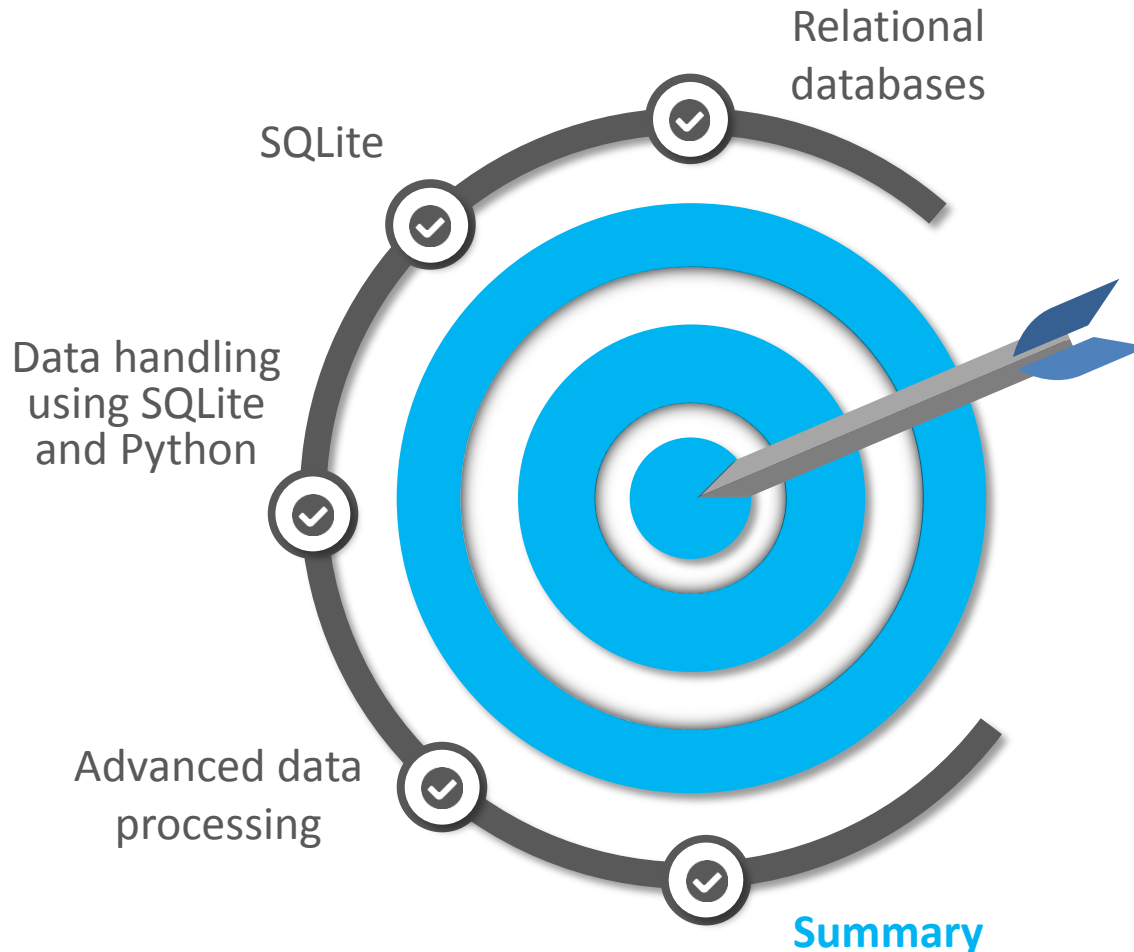
# Advanced processing of data

## Task

- Ask 5 more complex questions to the Titanic dataset and use the functions **apply**, **groupby**, **replace**, **loc**, **map**.
- For example, you may create new features like we did with “Person” or “Title”. This process is called **feature engineering**.
- Create 5 charts that show your findings.
- Push your Jupyter Notebook into the folder “Session\_3” of your repository “DataScienceFoundations”.



# Contents



## Today's objective

- How to work with relational database - SQLite.
- How to perform advanced processing of data.

# Summary

- Why do we need to **clean** the data before performing any analysis?
- Why handling of **empty fields** is important?
- Why asking **clear questions** to the data is important?
- Why adding **docstrings** into your code is important?
- Why a **proper visualization** should be selected to communicate the retrieved insights to a client/general public?
- What is feature engineering and why do we need it?
- Why do we need to convert all non-numerical variables into numerical variables before applying **the prediction model, like regression model**? How this conversion can be done?

# Individual assignment (graded)

- Select any dataset from Kaggle, UCI repository (<https://archive.ics.uci.edu/ml>), or any City Council open data source, etc.
- For this assignment the data should be in CSV format and should not exceed 10 Mb.
- Load the data into SQLite DB (check that data types are correct).
- Retrieve the data from Python using Pandas.
- Ask and answer 20 questions to your dataset.
- Create visualizations to communicate your major findings (at least 5 visualizations).
- Put comments and docstrings to your code.
- Push your Jupyter Notebook (in \*.ipynb format) and the database file (in \*.db format) into the folder “Session\_3\_graded\_assignment” of your repository “DataScienceFoundations.”



BARCELONA

Barcelona Technology  
School