École Supérieure en Sciences et Technologies de l'Informatique et du Numérique

2nd Cycle Department 1st year Speciality Class 2023 – 2024 Databases

Practical Assignments 03 :
Integrity Contraints & Insertions

Part I. Integrity Constraints

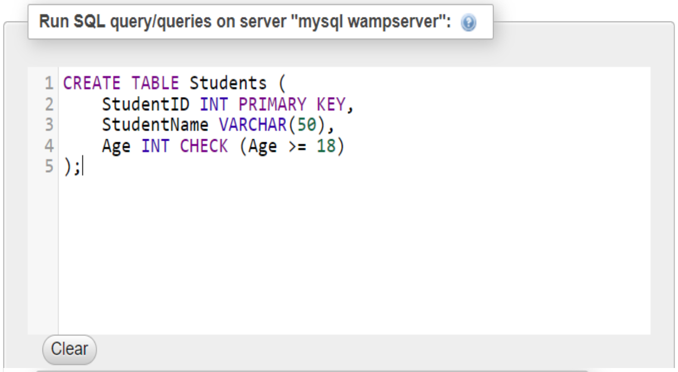
What are integrity constraints?

Integrity constraints are pre-defined rules that are applied to the table fields or relations to maintain the overall validity, integrity, and consistency of the data present in the database table. These constraints are protocols that a table's data columns must follow, and they are used to restrict the types of information that can be entered into a table.
Integrity constraints are essential in ensuring data quality and consistency in databases. They help to prevent accidental damage to the database by authorized users by ensuring that the data remains consistent when changes are made to the database. Every time there is an insertion, deletion, or updating of data in the database, it is the responsibility of these integrity constraints to maintain the integrity of data.
We divide integrity constraints into two types, domain constraints which constraint the definition domain of an attribute and key constraints, which are related to the key attributes.
The following examples demonstrate how to create tables with different types of constrained attributes.
It is always possible to create the table and then add the constraints later on with one of the commands
ALTER TABLE table_name **MODIFY** attribute_name **…**
ALTER TABLE table_name **ADD CONSTRAINT** constraint_name **…**

Domain Constraints

CHECK Constraint:
This constraint restricts the values that a column can hold
CHECK (<condition>)

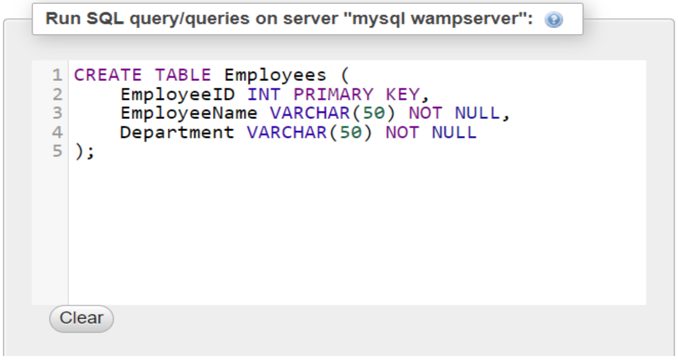
```
ALTER TABLE Students ADD CONSTRAINT
Ck_Employees CHECK (Age >= 18);
```



```
CREATE TABLE Students (
    StudentID INT PRIMARY KEY,
    StudentName VARCHAR(50),
    Age INT CHECK (Age >= 18)
);
```

NOT NULL Constraint:
This constraint ensures that a column cannot hold NULL values.

```
ALTER TABLE Employees MODIFY EmployeeEmail
VARCHAR(50) NOT NULL;
```



```
CREATE TABLE Employees (
    EmployeeID INT PRIMARY KEY,
    EmployeeName VARCHAR(50) NOT NULL,
    Department VARCHAR(50) NOT NULL
);
```

Practical Assignments 03 :
Integrity Contraints & Insertions

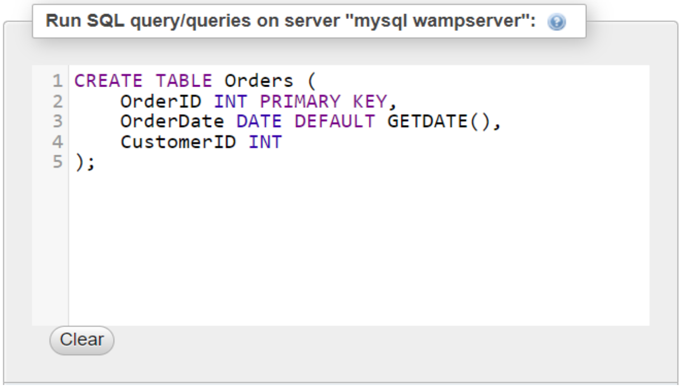
DEFAULT Constraint:

This constraint is used to provide a default value value for a column when no no value is specified during an insert.

Example:

GETDATE() is a function that is used to retrieve the current date and time from the system

```
ALTER TABLE Orders MODIFY OrderDate DATE
DEFAULT GETDATE();
```



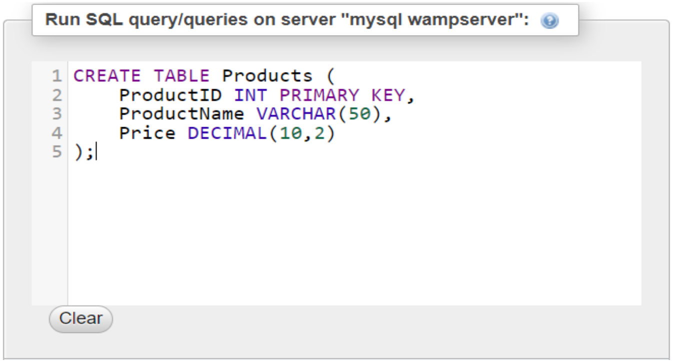
```
CREATE TABLE Orders (
    OrderID INT PRIMARY KEY,
    OrderDate DATE DEFAULT GETDATE(),
    CustomerID INT
);
```

Key Constraints

PRIMARY KEY Constraint :

This constraint uniquely identifies each record in a database table.

```
ALTER TABLE Products ADD CONSTRAINT pk_product
PRIMARY KEY(ProductID);
```



```
CREATE TABLE Products (
    ProductID INT PRIMARY KEY,
    ProductName VARCHAR(50),
    Price DECIMAL(10,2)
);
```

There can be compound primary keys.

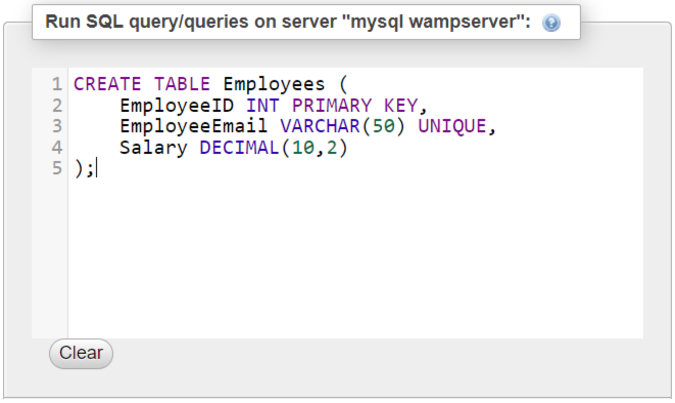
Example:

```
CREATE TABLE tab_name(
    atr1 INT,
    atr2 INT,
    atr3 INT,
    CONSTRAINT fk_1 FOREIGN KEY(atr1) REFERENCES another_tab_1 (another_atr_1),
    CONSTRAINT fk_2 FOREIGN KEY(atr2) REFERENCES another_tab_2 (another_atr_2),
    CONSTRAINT pk PRIMARY KEY(atr1, atr2)
    );
```

UNIQUE Constraint:

This constraint ensures that all values in a column are unique.

```
ALTER TABLE Employees ADD CONSTRAINT
uk_employee UNIQUE(EmployeeEmail);
```



```
CREATE TABLE Employees (
    EmployeeID INT PRIMARY KEY,
    EmployeeEmail VARCHAR(50) UNIQUE,
    Salary DECIMAL(10,2)
);
```

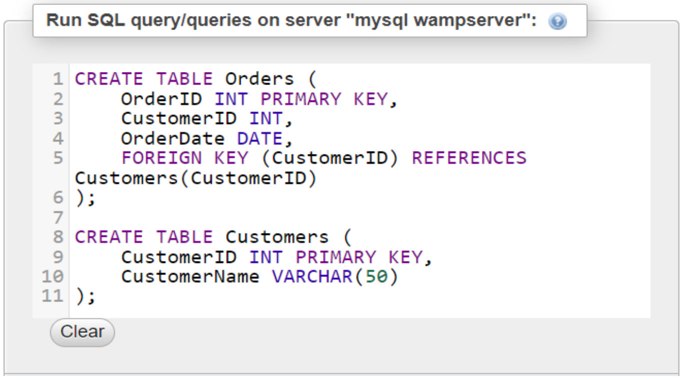
École Supérieure en Sciences et Technologies de l'Informatique et du Numérique

2nd Cycle Department 1st year Speciality Class 2023 – 2024 Databases

Practical Assignments 03 :
Integrity Contraints & Insertions

FOREIGN KEY Constraint:

This constraint is used to create a relationship between two tables.
Since foreign key attributes in a table reference attributes in a foreign table, there are special referential actions that can be defined when creating or altering a foreign key, which are 'ON UPDATE' and 'ON DELETE'. These will be covered in part of these series.



```
CREATE TABLE Orders (
    OrderID INT PRIMARY KEY,
    CustomerID INT,
    OrderDate DATE,
    FOREIGN KEY (CustomerID) REFERENCES
Customers(CustomerID)
);

CREATE TABLE Customers (
    CustomerID INT PRIMARY KEY,
    CustomerName VARCHAR(50)
);
```

Why name constraints?

Naming constraints is a good practise that helps improve readability, maintainability and reliability of a database. By knowing the name of the constraint we can alter the constraint.

```
CREATE TABLE tab_name_(
    pk_atr VARCHAR(2) PRIMARY KEY
    );

CREATE TABLE tab_name(
    atr1 INT,
    atr2 VARCHAR(2),
    constraint pk_cons primary key (atr1),
    constraint fk_cons foreign key (atr2) references tab_name_(atr3)
    );
```

How to show all the constraints?

```
SELECT CONSTRAINT_NAME FROM INFORMATION_SCHEMA.TABLE_CONSTRAINTS;
```

How to show the constraints of a table called 'table_name'?

```
SELECT CONSTRAINT_NAME FROM INFORMATION_SCHEMA.TABLE_CONSTRAINTS
WHERE TABLE_NAME = 'table_name';
```

How to show all the constraints labeled by the name, the constraint type and the table name?

```
SELECT CONSTRAINT_NAME, CONSTRAINT_TYPE, TABLE_NAME FROM
INFORMATION_SCHEMA.TABLE_CONSTRAINTS
```

Knowing a constraint's name, how to modify it?

```
ALTER TABLE child_table_name
DROP FOREIGN KEY fk_name,
ADD CONSTRAINT fk_name
FOREIGN KEY (child_column_name)
REFERENCES parent_table_name (parent_column_name)
ON DELETE CASCADE
ON UPDATE CASCADE;
```

Practical Assignments 03 :
Integrity Contraints & Insertions

Application:

Using SQL command line, create a database called 'music-db' containing the below tables and constraints.

- Modify 'Artists' table and add a constraint to 'Genre' that accepts either 'f' for female or 'm' for male
- Modify 'Songs' table and add a constraint to the attribute 'Duration' restricting the value to be >'00:00:00'
- Add a constraint to 'Artists' table to ensure that 'ArtistName' is not null
- Add a constraint to 'Artists' table to ensure that the values of 'Email' column are unique

Attribute	Type	Constraint
Songs		
SongID	Integer	primary key
SongName	Varchar(100)	not null
Artist	Integer	references an artist
Album	Integer	references an album
Genre	Varchar(1)	
ReleaseDate	Date	
Duration	Time	
Albums		
AlbumID	Integer	primary key
AlbumName	Varchar(100)	not null
ReleaseDate	Date	
Genre	Varchar(50)	
Artists		
ArtistID	Integer	primary key
ArtistName	Varchar(100)	
Email	Varchar(100)	
Country	Varchar(50)	
Genre	Varchar(50)	
Playlists		
PlaylistID	Integer	primary key
PlaylistName	Varchar(100)	not null
PlaylistDetails		
PlaylistDetailID	Integer	primary key
Playlist	Integer	references a playlist
Song	Integer	references a song

In the following assignments, we will represent entities in a relational model as such:
Artists(ArtistID, ArtistName, Email, Country, Genre)
PlaylistDetails(PlaylistDetailID, Playlist#, Song#)

Underlined attributes represent primary keys
attributes marked with # represent foreign keys

Practical Assignments 03 :
Integrity Contraints & Insertions

Part II. Insertions

Understanding insertions

Insertion commands allow you to create instances of the entities in your database.

Inserting

When inserting data of the types VARCHAR, TEXT, and DATE, the text values should be enclosed in single quotation marks (' '). This formatting is necessary to differentiate the textual data from the SQL commands and to ensure that the database interprets the values as literal text rather than as SQL commands. On the other hand, when the column is numeric, there is no need to use quotation marks. You simply need to specify the number.

1. Inserting multiple rows

It is possible to insert multiple tuples to a table using one query.
NB. The order is important.

```
INSERT INTO table_name_ VALUES (val1, val2, ...), (val1_, val2_, ...), ...;
```

2. Inserting one row at a time

It's also possible to insert one tuple at a time. There are two ways of doing so:

a. Inserting by order

```
INSERT INTO table_name_ VALUES (val1, val2, ...);
```

b. Inserting with column name

Here the order is not important because we specify the name of the column.

```
INSERT INTO table_name_ (column1, column2, ...) VALUES (val1, val2, ...);
```

Updating

The UPDATE command allows you to update one or more values in the same row of a table, potentially satisfying a given logical expression (predicate). The general syntax for this command is:

```
UPDATE table_name_ SET col1 = expr1 [,col2 = exp2 ...] [WHERE predicate];
```

Deleting

The DELETE command allows you to delete rows from a table that satisfy a given expression (predicate) or can be used to delete all rows from a table. The general syntax for this command is:

```
DELETE FROM table_name [WHERE predicate];
```

The WHERE clause is optional; if omitted, all rows of the table will be deleted.

Example of a predicate:

```
DELETE FROM tab_name WHERE atr1 = 'value';
```

Application

École Supérieure en Sciences et Technologies de l'Informatique et du Numérique

2nd Cycle Department 1st year Speciality Class 2023 – 2024 Databases

Practical Assignments 03 :
Integrity Contraints & Insertions

Creating the database

Using sql queries, create the library database described by the following relational model:
Entities tables:
Books(ISBN, title, publisher#, publicationDate, genre)
Authors(authorID, authorName, email, age, country)
Publishers(publisherID, publisherName, headquartersLocation, foundationYear, website)
Members(memberID, name, email, phone, address)
Relationship tables:
WrittenBy(book#, author#)
BookLoans(loanID, book#, member# , borrowDate, returnDate, dueDate)

- All Ids are declared as integers
- 'phone' is a string of characters
- 'email' should be unique
- 'website' should be unique
- AuthorID, publisherID, memberID, loanID should AutoIncrement

Populating the database

Populate the database with the following information

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97801424	To Kill a Mockingbird	1	1960-07-11	Fiction
97800611	1984	2	1949-06-08	Science Fiction
97805479	The Hobbit	3	1937-09-21	Fantasy
97800629	The Push	2	2021-01-05	Psychological Thriller
97803582	The Silent Patient	2	2019-02-05	Psychological Thriller
97803583	The Ballad of Songbirds and Snakes	1	2020-05-19	Dystopian Fiction
97803584	The Midnight Library	4	2020-09-29	Fiction
97805931	The Testaments	1	2019-09-10	Dystopian Fiction

Authors table				
authorI	**authorName**	**email**	**ag**	**countr**

Practical Assignments 03 :
Integrity Contraints & Insertions

D			e	y
1	Harper Lee	harperlee@gmail.com	89	USA
2	George Orwell	georgeorwell@gmail.com	46	UK
3	J.R.R. Tolkien	tolkien@gmail.com	81	UK

Publishers table

publisherID	publisherName	headquartersLocation	foundationYear	website
1	Penquin Random House	New York, NY	2014	https://www.penguinrandomhouse.com/
2	HarperCollins	New York, NY	1989	https://www.harpercollins.com/
3	Houghton Mifflin Harcourt	Boston, MA	1832	https://www.hmhbooks.com/
4	Penguin Classics	London, UK	1935	https://www.penguin.co.uk/
5	HarperOne	San Francisco, CA	1977	https://www.harperone.com/
6	St. Martin's Press	New York, NY	1952	https://us.macmillan.com/smp
7	Doubleday	New York, NY	1897	https://www.penguinrandomhouse.com/imprints/double/

Members table

memberID	name	email	phone	address
1	John Smith	johnsmith@gmail.com	555-1234	123 Main St
2	Jane Doe	janedoe@gmail.com	555-5678	456 Elm St
3	Bob Johnson	bobjohnson@gmail.com	555-9012	789 Oak St

WrittenBy table

book	author
97801424	1
97800611	2

BookLoan table

loanID	book#	member#	borrowDate	returnDate	dueDate
1	97801424	1	2023-10-01	2023-10-08	2023-10-15
2	97800611	2	2023-10-02	2023-10-09	2023-10-16
3	97805479	3	2023-10-03	2023-10-10	2023-10-17

Write the appropriate queries to implement the following insertions and comment the results:

- Insert into authors table the values (4,’JRT’, ‘tolkien@gmail.com’, 50, ‘UK’)

Practical Assignments 03 :
Integrity Contraints & Insertions

- Update publisherYear in Publishers table where publisherID = 1, and change its value from 2014 to 2013
- Add the following information to the database: Book 97805479 is written by author 3
- Member 1 comes to the library and borrows book 97800611 today. Add this information to the database (use CURDATE() function to get today's date).

Part III. Modifying the structure of a table

What is it?

Modifying the structure of tables is an important part of database management as requirements change over time. There are various ways to modify tables in SQL including adding or removing columns, changing data types, adding or removing constraints, and renaming or dropping tables. Some common modifications:

a) Adding new columns to store additional data attributes. This involves specifying the new column name, data type, any constraints like NOT NULL or DEFAULT, and where in the table to add it.

ALTER TABLE ”name_table” ADD ”column_name” type NOT NULL,

b) Removing unneeded columns using DROP COLUMN when certain attributes are no longer required. Any constraints or dependencies on the dropped column also need to be removed.

ALTER TABLE “name_table” DROP ”(column_name1, column_name2 …)”

c) Changing the data type of a column using ALTER TABLE to increase field sizes for more data capacity or modify the type for different data attributes.

ALTER TABLE ”name_table” MODIFY ”(column_name)” type NULL/NOT NULL

d) Modify name of column.

RENAME COLUMN “Table.old_column_name” TO “Table.new_column_name”.

e) Dropping entire tables that are obsolete using DROP TABLE to clean up the database. References to the dropped tables should be removed from other objects first.

DROP TABLE “name_table”

f) Rename Table name:

RENAME TABLE “old_name” TO “new _name”

g) Delete Primary key from a table:

ALTER TABLE mytable DROP PRIMARY KEY

Application

Practical Assignments 03 :
Integrity Contraints & Insertions

Use the database created in the previous part and write the appropriate queries to implement the following functions.

1. Add a new column, called 'rating', to the Books table to store a rating out of 5 for each book. Make sure to specify the data type and any constraints.
2. Remove the 'age' column from the Authors table as you decide you don't need to store the authors' ages.
3. Increase the size of the 'title' column in the Books table from 25 characters to 50 characters.
4. Change the data type of the 'publicationDate' column in the Books table from DATE to DATETIME so it stores the time as well as date.
5. Add a new table called 'BookCategories' with columns 'categoryID', 'categoryName'.
6. Add a column 'categoryID' to the Books table as a foreign key to associate each book with a category.
7. Add a default constraint to the 'rating' column in Books so unrated books automatically get a rating of 3.
8. The Publishers table is no longer needed in the database. Drop the publisher table.
9. It has been decided that the BookLoans table needs to be renamed to Loans to better reflect that it records loans of any library item. Rename the BookLoans table to Loans.
10. The memberID column is currently the primary key in the Members table. This column is no longer needed.

Practical Assignments 03 :
Integrity Contraints & Insertions

Part IV. Deletion and Update Triggers

What are they?

Triggers in SQL are used to automatically execute a set of SQL statements when a specific event occurs in the database. The purpose of triggers **'ON DELETE'** and **'ON UPDATE'** is to perform certain actions when a DELETE or UPDATE operation is executed on a table.

'ON DELETE' trigger

The purpose of 'ON DELETE' trigger is to perform certain actions when a row containing a referenced field is deleted. Four scenarios are possible:

CASCADE	indicates the cascading deletion of rows in the table whose foreign key value corresponds to that of the deleted row's primary key.
RESTRICT	indicates an error in the event of deleting a primary key value corresponding to a foreign key row.
SET NULL	sets the value to NULL in the rows of the table whose foreign key value corresponds to that of the deleted row's primary key.
NO ACTION	Rows in the table whose foreign key value corresponds to that of the deleted row's primary key remain unchanged.

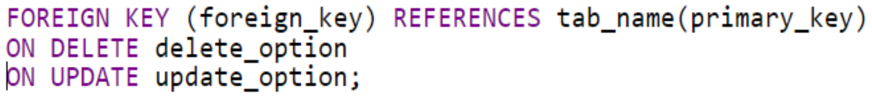
'ON UPDATE' trigger

The purpose of 'ON UPDATE' trigger is to perform certain actions when a row containing a referenced field is updated. Four scenarios are possible:

CASCADE	indicates the cascading update of rows in the table whose foreign key value corresponds to that of the deleted row's primary key.
RESTRICT	indicates an error in the event of updating a primary key value corresponding to a foreign key row.
SET NULL	sets the value to NULL in the rows of the table whose foreign key value corresponds to that of the updated row's primary key.
NO ACTION	Rows in the table whose foreign key value corresponds to that of the updated row's primary key remain unchanged.

Syntax

The syntaxe is the following



```
FOREIGN KEY (foreign_key) REFERENCES tab_name(primary_key)
ON DELETE delete_option
ON UPDATE update_option;
```

Where 'delete_option' and 'update_option' are one of the previously described scenarios; CASCADE, RESTRICT, SET NULL, NO ACTION.
NB. The default value is RESTRICT.

Application

École Supérieure en Sciences et Technologies de l'Informatique et du Numérique

2nd Cycle Department 1 st year Speciality Class 2023 – 2024 Databases

Practical Assignments 03 :
Integrity Contraints & Insertions

You are asked to export the previous populated database to conserve it since you will do some updating and deletion operations in the following assignment.
To better understand and visualize what happens to the referring column (the foreign key) once we modify the referenced column (primary key), we propose the following assignment.
For each scenario (CASCADE, RESTRICT, SET NULL, NO ACTION) and for each case (DELETING or UPDATING) do the following:

- Alter the books table and modify the foreign key adding one of the options above as a trigger
- Then according to the case (deletion or updating) delete or update the mentioned publisher accordingly and comment what happens to the books table as stated below
- Restore the tables to their previous state and try it again with another scenario

Deletion

Delete publisher with publisherID = 3, and comment what happens to the book(s) referencing it in each scenario

Publishers table				
publisherID	**publisherName**	**headquartersLocation**	**foundationYear**	**website**
3	Houghton Mifflin Harcourt	Boston, MA	1832	https://www.hmhbooks.com/

CASCADE

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97801424	To Kill a Mockingbird	1	1960-07-11	Fiction
97800611	1984	2	1949-06-08	Science Fiction
97805479	The Hobbit		1937-09-21	Fantasy

RESTRICT

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97801424	To Kill a Mockingbird	1	1960-07-11	Fiction
97800611	1984	2	1949-06-08	Science Fiction
97805479	The Hobbit		1937-09-21	Fantasy

SET NULL

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
9780142	To Kill a	1	1960-07-11	Fiction

4	Mockingbird			
97800611	1984	2	1949-06-08	Science Fiction
97805479	The Hobbit		1937-09-21	Fantasy

NO ACTION

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97801424	To Kill a Mockingbird	1	1960-07-11	Fiction
97800611	1984	2	1949-06-08	Science Fiction
97805479	The Hobbit		1937-09-21	Fantasy

Updating

Update publisher and change publisherID value from 4 to 3, and then comment what happens to the book(s) referencing it

Publishers table				
publisherID	**publisherName**	**headquartersLocation**	**foundationYear**	**website**
3	Penguin Classics	London, UK	1935	https://www.penguin.co.uk/

CASCADE

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97803584	The Midnight Library		2020-09-29	Fiction

RESTRICT

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97803584	The Midnight Library		2020-09-29	Fiction

SET NULL

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97803584	The Midnight Library		2020-09-29	Fiction

NO ACTION

Books table				
ISBN	**title**	**publisher**	**publicationDate**	**genre**
97803584	The Midnight Library		2020-09-29	Fiction

Application 2

In the original database, for all foreign keys in child tables, set option cascade for updating and set null for deleting.