BT5110 Data Management and Warehousing

Tutorial 1: Tutorial Creating & Populating Tables with Constraints

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Greeting!

Welcome to BT5110!

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Been in cyber-security R&D industry since 2014, came back NUS for PhD in 2019

I will be your TA for the first half of the semester!

Question 1 (a-b)

(a) Download the following files from Luminus "Files > Cases > Book Exchange".

`NUNStASchema.sql`,

`NUNStAStudent.sql`,

`NUNStABook.sql`,

`NUNStACopy.sql`,

`NUNStALoan.sql`, and `NUNStAClean.sql`.

(b) Read the SQL files. What are they doing?

(c) Use the files to create and populate a database (they may need some bug fixing).

Solution 1 (b)

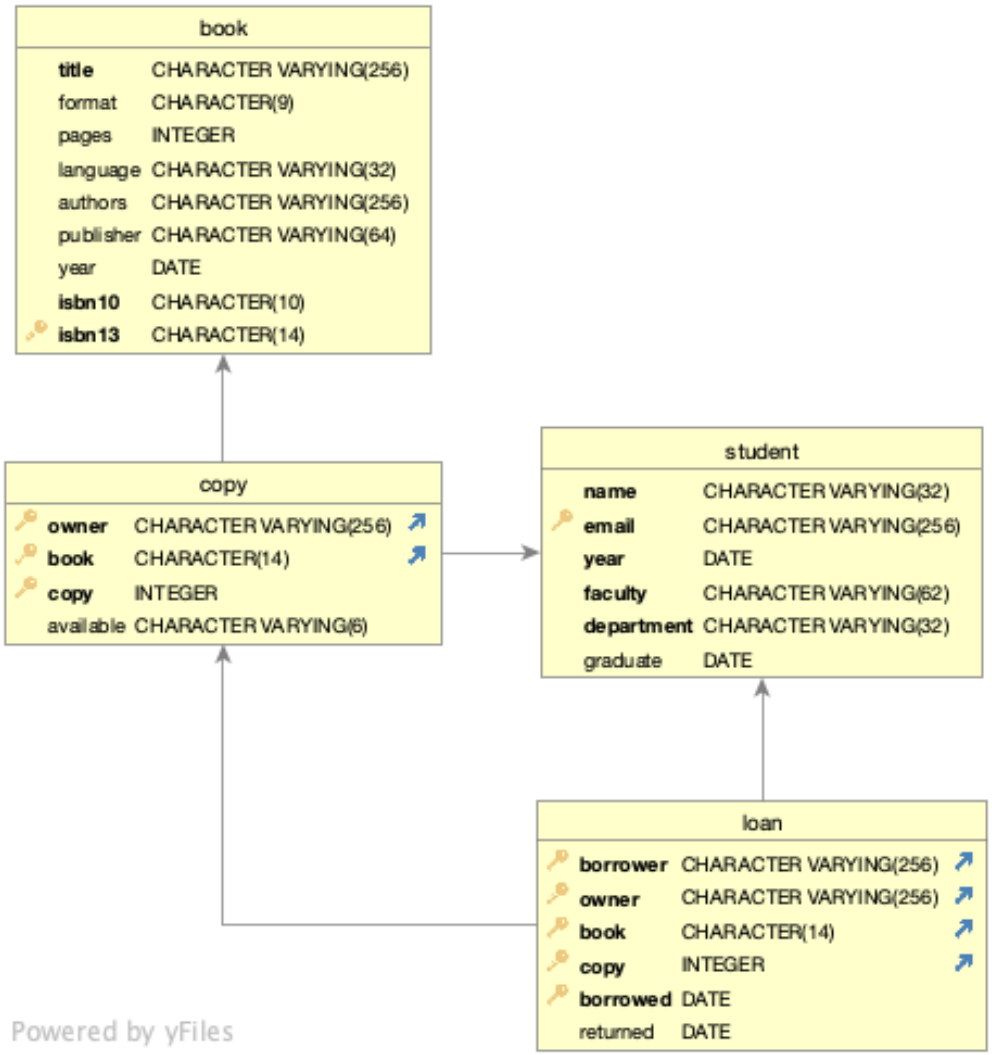


Figure: ER Diagram of NUNStASchema

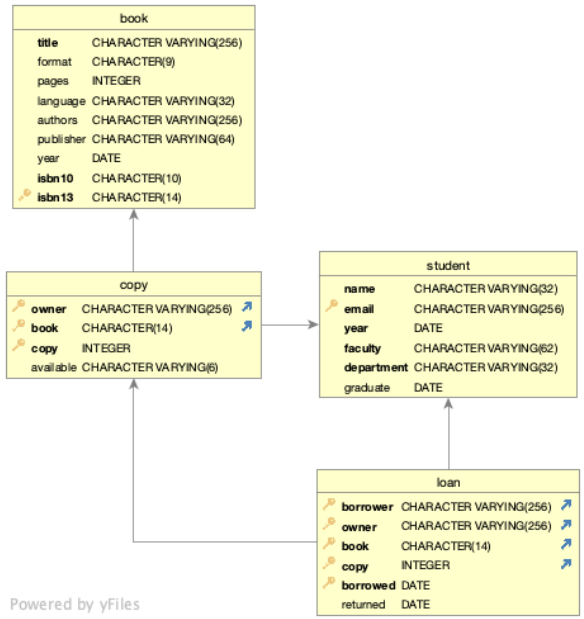
Solution 1 (b) Cont.

The first file to be run is `NUNStASchema.sql`. It creates the different tables. The referential integrity constraints (`FOREIGN KEY`) impose that the table `copy` and the table `loan` are created after the tables `student` and `book` and in that order.

The table `student` is populated using `NUNStAStudent.sql`.

The table `book` is populated using `NUNStABook.sql`.

These two tables can be populated in any order.



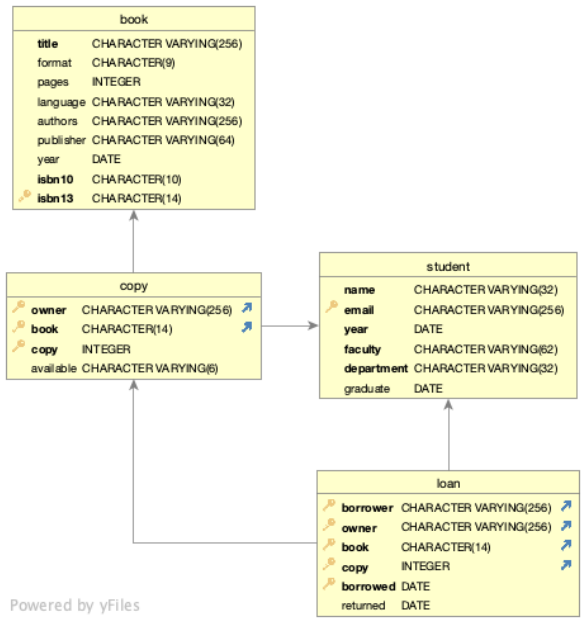
Solution 1 (b) Cont.

The table copy is populated using `NUNStACopy.sql`.

The table `loan` is populated using `NUNStALoan.sql`.

The table copy and the table `loan` can only be populated after the tables `student` and book are populated and in that order because of the referential integrity constraints (`FOREIGN KEY`).

The referential integrity constraints (`FOREIGN KEY`) impose that the table `loan` and the table copy are deleted before the tables `student` and book and in that order in `NUNStAClean.sql` matters.



Solution 1 (c)

There is a bug in `NUNStASchema.sql`, as the populating order of table `loan` (line 29-39) and `copy` (line 41-47) are wrong.

You can fix it by ***swapping*** these two code sections.

Then execute all SQL files except `NUNStAClean.sql` through PgAdmin.

Notice

You need to execute all those SQL files except `NUNStAClean.sql` for the sequential quesitons.

Question & Solution 2 (a)

Insert the following new book.

```
1   INSERT INTO book VALUES (
2     'An␣Introduction␣to␣Database␣Systems',
3     'paperback' ,
4     640 ,
5     'English' ,
6     'C.␣J.␣Date' ,
7     'Pearson',
8     '2003-01-01' ,
9     '0321197844' ,
10    '978-0321197849');
```

Solution: Notice the implicit order of the fields.
You can check that the insertion was effective with the following query.

```
1   SELECT * FROM book;
```

Question & Solution 2 (b)

Insert the same book with a different `ISBN13`, for instance `'978-0201385908'`.

Solution: Execute the code bellow:

```
1  INSERT INTO book VALUES (
2    'An Introduction to Database Systems',
3    'paperback',
4    640,
5    'English',
6    'C.J. Date',
7    'Pearson',
8    '2003-01-01',
9    '0321197844',
10   '978-0201385908');
```

Solution 2 (b) Cont.

The command yields an error because `ISBN10` must be unique. PostgreSQL returns the following error message.

```
ERROR:  duplicate key value violates unique constraint "book_isbn10_key"
DETAIL:  Key (isbn10)=(0321197844) already exists.
SQL state: 23505
```

Remark

All messages emitted by the PostgreSQL server are assigned five-character error codes that follow the SQL standard's conventions for "SQLSTATE" codes. Applications that need to know which error condition has occurred should usually test the error code, rather than looking at the textual error message.

See `www.postgresql.org/docs/13/errcodes-appendix.html`

Question & Solution 2 (c)

Insert the same book with the original `ISBN13` but with a different `ISBN10`, for instance `'0201385902'`.

Solution: Execute the code bellow:

```
1  INSERT INTO book VALUES (
2    'An Introduction to Database Systems',
3    'hardcover',
4    938,
5    'English',
6    'C.J. Date',
7    'Addison Wesley Longman',
8    '2000-01-01',
9    '0201385902',
10   '978-0321197849');
```

Solution 2 (c) Cont.

The command yields an error because `ISBN13` is a primary key and therefore unique. PostgreSQL returns the following error message.

```
ERROR:  duplicate key value violates unique constraint "book_pkey"
DETAIL:  Key (isbn13)=(978-0321197849) already exists.
SQL state: 23505
```

Question & Solution 2 (d)

Insert the following new student.

```
1  INSERT INTO student VALUES (
2    'TIKKI TAVI' ,
3    'tikki@gmail.com' ,
4    '2010-01-01',
5    'School of Computing',
6    'CS',
7    NULL);
```

Notice that the value of the field year is NULL. This is because the student has not yet graduated.

Question & Solution 2 (e)

Insert the following new student.

```
1  INSERT INTO student (email, name, year, faculty, department)
2    VALUES (
3    'rikki@gmail.com',
4    'RIKKI TAVI',
5    '2010-01-01',
6    'School of Computing',
7    'CS');
```

Notice how we explicitly indicate the order of the fields in the insertion command. In this case, if a field is omitted, the system attempts to insert a null value.

Question & Solution 2 (e) Cont.

Try the following insertion.

```
1   INSERT INTO student (name, year, faculty, department)
2     VALUES (
3     'RIKKI TAVI',
4     '2010-01-01',
5     'School of Computing',
6     'CS');
```

The command does not work because email is a primary key and therefore cannot be null.

```
ERROR:  null value in column "email" violates not-null constraint
DETAIL:  Failing row contains (RIKKI TAVI, null, 2010-01-01,
School of Computing, CS, null).
SQL state: 23502
```

Question & Solution 2 (f)

Change the name of the department 'CS' to 'Computer Science'.

```
1  UPDATE student
2  SET department = 'Computer␣Science'
3  WHERE department = 'CS';
```

You can check that the update was effective with the following queries. The first query has no result.

```
1  SELECT * FROM student WHERE department = 'CS';
```

The second query prints the students from the computer science department.

```
1  SELECT * FROM student WHERE department = 'Computer␣Science';
```

Question & Solution 2 (g)

Delete the students from the 'chemistry' department.

```
1  DELETE FROM student
2  WHERE department = 'chemistry';
```

'chemistry' is misspelled with a lower case 'c'. There is no error but nothing is deleted because there is no department 'chemistry'.

Question & Solution 2 (h)

Delete the students from the 'Chemistry' department.

```
1  DELETE FROM student
2  WHERE department = 'Chemistry';
```

Nothing is deleted because a constraint is violated. It is not a programming error. It is part of the control of the access to the data.

```
ERROR:  update or delete on table "student" violates foreign key constraint
      "loan_borrower_fkey" on table "loan"
DETAIL:  Key (email)=(xiexin2011@gmail.com) is still referenced from table
     "loan".
SQL state: 23503
```

Question & Solution 3 (a)

Some constraints in PostgreSQL are `DEFERRABLE`. What does it mean?

Upon creation, a `UNIQUE`, `PRIMARY KEY`, or `FOREIGN KEY` constraint is given one of three characteristics: `DEFERRABLE INITIALLY IMMEDIATE`, `DEFERRABLE INITIALLY DEFERRED`, and `NOT DEFERRABLE`.

By default the above constraints and all others are `NOT DEFERRABLE`. A `NOT DEFERRABLE` constraint is always `IMMEDIATE`. By default a `DEFERRABLE` constraint is `INITIALLY IMMEDIATE`.

These qualifications refers to when the constraint is checked: immediately after each operation (`INSERT`, `DELETE`, `UPDATE`), or at the end of the transaction executing the operation.

Although this is not the default setting, it is preferable that all constraints be deferred. Unfortunately, this is only possible for `UNIQUE`, `PRIMARY KEY`, and `FOREIGN KEY` constraints and not for `CHECK` constraints in the current version of PostgreSQL.

Question & Solution 3 (b)

Insert the following copy of 'An Introduction to Database Systems' owned by Tikki.

```
1  INSERT INTO copy VALUES (
2    'tikki@gmail.com',
3    '978-0321197849',
4    1,
5    'TRUE') ;
```

What is the difference between the following two SQL programs?

Question & Solution 3 (b) Cont.

```
1  BEGIN TRANSACTION;
2  SET CONSTRAINTS ALL IMMEDIATE;
3  DELETE FROM book
4  WHERE ISBN13 = '978-0321197849' ;
5  DELETE FROM copy
6  WHERE book = '978-0321197849' ;
7  END TRANSACTION;
```

In the first transaction, the statement `SET CONSTRAINTS ALL IMMEDIATE;` checks the reference from the table copy to the table book checkable after each operation. The first deletion of the transaction violates the constraint.

```
ERROR:  current transaction is aborted, commands ignored until end of
     transaction block
SQL state: 25P02
```

Question & Solution 3 (b) Cont.

This is the default, so the code below has the same issue.

```
1  BEGIN TRANSACTION;
2  DELETE FROM book
3  WHERE ISBN13 = '978-0321197849';
4  DELETE FROM copy
5  WHERE book = '978-0321197849';
6  END TRANSACTION;
```

When the execution is interrupted, you need to run "`END TRANSACTION;`" ***manually***.

You can also use commands like `BEGIN`, `COMMIT` as well as `SAVEPOINT my_savepoint` and
`ROLLBACK TO my_savepoint;` to control the flow of transactions.

Question & Solution 3 (b) Cont.

```
1  BEGIN TRANSACTION;
2  SET CONSTRAINTS ALL DEFERRED;
3  DELETE FROM book WHERE ISBN13 = '978-0321197849' ;
4  DELETE FROM copy WHERE book = '978-0321197849' ;
5  END TRANSACTION;
```

In the second transaction, the constraints are checked at the end of the transaction and are not violated. Namely, `SET CONSTRAINTS ALL DEFERRED` makes the reference from the table copy to the table book checkable at the end of transactions. The combined effect of the two deletions in the transaction does not violate the FOREIGN KEY constraint. The transaction is committed.

Note that SQLite has a pragma called `defer_foreign_keys` to control deferred foreign keys.

Question & Solution 4 (a)

Argue that there is no need for the `available` field of the table `copy`. Make the necessary changes.

Solution: The availability of a copy can be derived. The following query

finds the copies loaned but not returned and therefore not available.

```
1  SELECT owner, book, copy, returned
2  FROM loan
3  WHERE returned ISNULL;
```

We drop the `available` field in the table `copy`

```
1  ALTER TABLE copy
2  DROP COLUMN available;
```

Question & Solution 4 (a) Cont.

We could even create a view copy_view with the field restored.

```
1   CREATE OR REPLACE VIEW copy_view (owner, book, copy, available)
2   AS (SELECT DISTINCT c.owner, c.book, c.copy,
3   CASE
4     WHEN EXISTS (SELECT * FROM loan l
5     WHERE l.owner = c.owner
6       AND l.book = c.book
7       AND l.copy = c.copy
8       AND l.returned ISNULL)
9     THEN 'FALSE'
10    ELSE 'TRUE'
11  END
12  FROM copy c);
13
14  SELECT * FROM copy_view;
```

Question & Solution 4 (a) Cont.

Can the view be updated?

```
1  UPDATE copy_view
2  SET owner = 'tikki@google.com'
3  WHERE owner = 'tikki@gmail.com'
```

In principle we should be able to update all fields except `available`.

It is however not directly possible but it can be programmed using `INSTEAD OF UPDATE` triggers or unconditional `ON UPDATE DO INSTEAD` rules.

```
1  DROP VIEW copy_view;
```

Question & Solution 4 (b)

Argue that the table `student` should not contain both the fields `department` and `faculty`. Make the necessary changes.

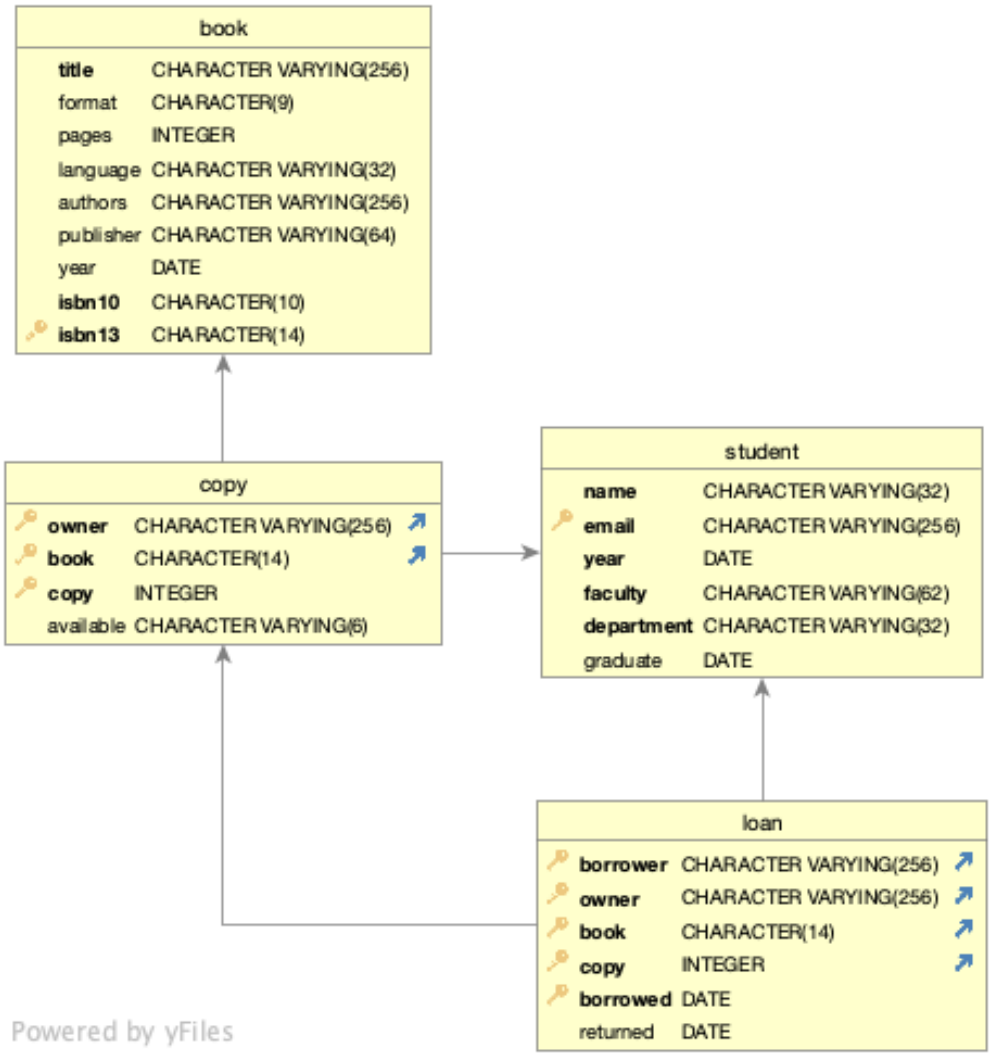
Solution: The faculty is determined by the department. This information can be stored once and for all in a separate table. The student table needs only to store the department.

The changes can be done with the following SQL code.

```
1   CREATE TABLE department (
2     department VARCHAR(32) PRIMARY KEY,
3     faculty VARCHAR(62) NOT NULL);
4
5   INSERT INTO department
6   SELECT DISTINCT department, faculty FROM student;
7
8   ALTER TABLE student DROP COLUMN faculty;
9
10  ALTER TABLE student
11  ADD FOREIGN KEY (department) REFERENCES department(department);
```

End of Tutorial 1

Below is what your database (should) be like by the end of this tutorial:



For any further question, please feel free to email me:

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See you next week!