Basics of Database Systems

Project – Database design

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1 WHAT WAS DONE IN THE PROJECT

Grading criteria	Done?	Max points given
Submitted files	X	4p
Report is readable and sensible	X	2p
Report contains all necessary parts (some parts are separately checked)	X	2p
Report has a data model	X	2p
Data model has at least one N:M relationship	X	2p
Data model has max&min cardinalities	X	2p
Number of entities in the data model (eight required)	8	8p
The primary and foreign keys defined make sense	X	2p
Number of select queries / views (five required)	5	3p
Queries are somewhat different and they work	X	3p
Most queries/views provide useful information	X	2p
At least one query uses two JOIN clauses	X	2p
Each table has at least ten rows of data	X	2p
Database file and SQL files work	X	2p
There is at least one of each type of integrity constraints (NOT NULL, UNIQUE, CHECK, DEFAULT)	Did four	4p
Each FK has ON UPDATE and ON DELETE constraints	X	3p
Reasonable indices used (not just using primary keys)	-	1p
Database contains a trigger	-	3p
TOTAL POINTS	45	50p

2 DEFINITION

This database is designed for a library to manage their book collection, members, and lending activities. The system tracks books, their authors, publishers, members who borrow books, borrowing transactions, fines, and other events that occurs in a library. This is vital because librarians need to know which books are available, which members has borrowed which books, when items are due, and track fines for late returns.

The following database queries will be implemented:

(1) List all books currently checked out by a specific member.

(2) Show all books by a certain author and their current availability status

(3) Display overdue books with the member contact info and fines.

(4) List the most borrowed books in the last 30 days.

(5) Show a members borrowing history, return dates, and fines paid (if any).

3 MODELING

The ER diagram Figure 1 on page 6 shows the data model for the library database. There are eight entities in total: seven primary entities (Member, Book, Author, Publisher, Genre, Loan, Fine) and one interim relation (BookAuthor) which resolves the many-to-many (N:M) relationship between Book and Author. Most relationships between the entities are one-to-many, except for the relationship between Loan and Fine which is one-to-one (1:1).

Relationship	Cardinality	Min Cardinality	Max Cardinality	Reasoning
Member - Loan	1:N	1:0	1:N	A member can have many loans but each loan belongs to one member
Member – Fine	1:N	1:0	1:N	A member can have zero fines or many fines
Loan – Fine	1:1	1:0	1:1	One loan can at have most one fine or none
Loan - Book	N:1	1:0	1:1	A book can be loaned many times, but each loan is for exactly one book
Book – Publisher	N:1	1:1	N:1	Many books can have the same publisher, and every book must have one publisher
Book - Genre	N:1	1:1	N:1	Many books can be in the same genre, and each book must have one genre
Book - BookAuthor	1:N	1:1	1:N	A book can be written by one or many authors (through BookAuthor)
Author - BookAuthor	1:N	1:0	1:N	An author can write many books or none at all (through BookAuthor)

4 ER DIAGRAM

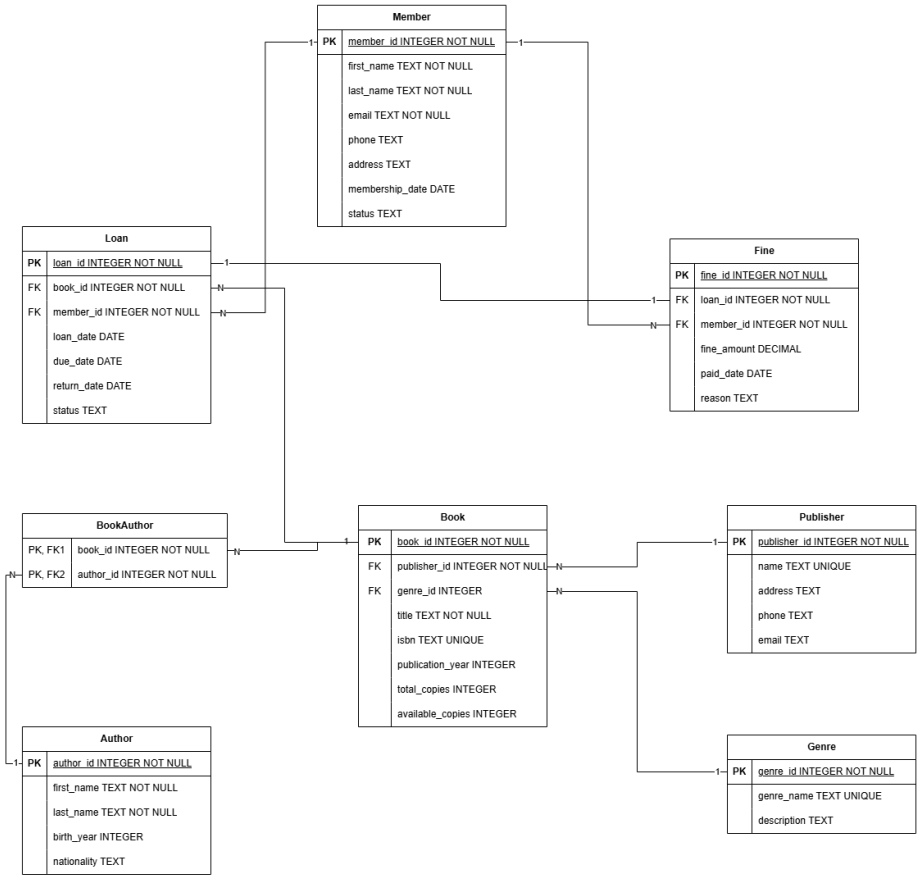

Figure 1: Data model (created in Draw.io)

5 DATABASE IMPLEMENTATION

During implementation, the following constraints are created for the relations:

- **Member**:
  - Foreign key to Loan (through Loan table), but no direct FK in Member table
  - Email must be unique (UNIQUE constraint)
  - Status has DEFAULT value is 'active'
  - Phone & Address can be null
  - CHECK constrain ensures status is either ‘active’ or ‘suspended’
- **Book**:
  - Foreign key to Publisher, cannot be null (NOT NULL)
    - ON UPDATE CASCADE / ON DELETE RESTRICT
  - Foreign key to Genre, cannot be null (NOT NULL)
    - ON UPDATE CASCADE / ON DELETE RESTRICT
  - ISBN must be unique (UNIQUE constraint)
  - Total_copies DEFAULT value of 1
  - Available_copies must be less than or equal to total_copies (CHECK constraint)
  - Publication year must be higher than year 1400 (CHECK constraint)
- Author:
  - First_name & last_name cannot be null (NOT NULL)
  - Birth_year can be null
  - Nationality DEFAULT value is 'Unknown'
- Publisher:
  - Name cannot be null (NOT NULL) and is UNIQUE
  - Address, phone, email can all be null
- Genre:
  - Genre_name cannot be null (NOT NULL) and is UNIQUE
  - Description can be null

- BookAuthor:
    - Composite primary key made of two foreign keys (book_id, author_id)
    - Neither FK can be null (NOT NULL)
        - ON UPDATE CASCADE / ON DELETE RESTRICT (for both)
- Loan:
    - Foreign key to Book, cannot be null (NOT NULL)
        - ON UPDATE CASCADE / ON DELETE RESTRICT
    - Foreign key to Member, cannot be null (NOT NULL)
        - ON UPDATE CASCADE / ON DELETE RESTRICT
    - Loan_date DEFAULT is current date
    - Due_date is calculated as loan_date + 14 days (can be set with DEFAULT)
    - Return_date can be null (null means not returned yet)
    - Status DEFAULT value is 'active'
    - CHECK constraint ensures return_date is null OR return_date >= loan_date
- **Fine**:
    - Foreign key to Loan, cannot be null (NOT NULL)
        - ON UPDATE CASCADE / ON DELETE CASCADE
    - Foreign key to Member, cannot be null (NOT NULL)
        - ON UPDATE CASCADE / ON DELETE NULL
    - Fine_amount DEFAULT value is 0.00
    - Paid_date can be null (null means that is has not paid yet)
    - Reason DEFAULT value is 'Late return'
    - CHECK constraint ensures fine_amount >= 0