

Project 447 Part 4

Team SQLibrary

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1 Project Overview

This database project focuses on designing a robust SQL-based Library Management System (LMS) that efficiently manages books, magazines, borrowers, transactions, and overdue monitoring. With the development of a relational schema, the project now emphasizes the logical structuring of data using entity-relationship (ER) modeling and relational mapping techniques. The system ensures data integrity through well-defined primary keys, foreign keys, and functional dependencies. By implementing a structured relational schema, the LMS enhances data accuracy, optimizes query performance, and maintains referential integrity, enabling streamlined library operations and improved decision-making capabilities for librarians.

2 Scope

The Library Management System (LMS) will manage various types of library materials, including physical and digital books, magazines, and user accounts. The system will enforce borrowing policies, track overdue items, regulate borrowing limits according to membership categories, enable reservations, and generate reports. In this phase, the focus is on mapping the conceptual ER model to a relational schema, defining attributes, primary keys, foreign keys, and establishing functional dependencies. The system will maintain strict normalization principles to minimize redundancy and ensure efficiency. However, it will not incorporate physical checkout mechanisms like barcode scanners or RFID tags, nor will it integrate with external content providers.

3 Glossary

- **3NF (Third Normal Form):** A normalization form ensuring that all attributes are functionally dependent only on the primary key and not on any non-key attributes.
- **DM:** Shorthand for Digital Media.
- **Foreign Key:** A field in one table that references the primary key of another table, ensuring referential integrity.
- **Functional Dependency:** A constraint that describes the relationship between attributes in a relation.
- **ISBN:** International Standard Book Number; a unique identifier assigned to books and other published materials.
- **Library Management System (LMS):** An architecture created to manage library assets, member enrollments, and transaction operations.
- **Membership Type:** A classification of customers that identifies the borrower ability and charge terms for these customers (e.g., normal, student, senior).
- **Normalization:** The process of organizing a database to reduce redundancy and improve data integrity.

- **Overdue Monitoring:** A device that tracks and records overdue books and calculates corresponding fees.
- **Primary Key:** A unique identifier for each record in a table.
- **Reservation:** A feature allowing clients to place holds on borrowed items.
- **Notifications:** Automated alerts for due dates, overdue items, and reserved book availability.
- **Relational Schema:** The structured representation of a database that defines relations (tables), attributes, and constraints.
- **Item:** A generalized category for the objects the library contains, categorized by the upper-case "I" to represent the entity that Digital Media, Magazine, and Book inherit from.

4 Relational Schema Mapping

4.1 Identify Relations

The following relations were identified from the ER diagram:

- Member
- MembershipType
- Item
- Book
- DigitalMedia
- Magazine
- Librarian
- Loan
- Fine
- Reservation

4.2 Attributes and Domains

The following tables have the corresponding attributes, and domains. Tables with no domain likely have too flexible of a description to accurately constrain to a domain, and are described in the data dictionary.

Table: Member

Attributes: MemberID (PK, INT), Name (VARCHAR(100)), Contact (VARCHAR(100)), TypeID (CHAR, FK), AccountStatus (ENUM)

Domains: AccountStatus \rightarrow ENUM('Active', 'Suspended', 'Closed')

Table: MembershipType

Attributes: TypeID (PK, CHAR), TypeName (VARCHAR(100)), BorrowLimit (INT), LateFeeRate (INT)

Domains: BorrowLimit ≥ 0 , LateFeeRate ≥ 0

Table: Item

Attributes: ItemID (PK, INT), Title (VARCHAR(255)), Availability (BOOL)

Domains: Availability \rightarrow BOOL (True/False)

Table: Book

Attributes: ItemID (PK, FK), Title (VARCHAR(255)), Author (VARCHAR(100)), Genre (VARCHAR(50)), PubYear (INT), Availability (BOOL)

Domains: PubYear $\in [1450, \text{CurrentYear}]$, where PubYear \leq CurrentYear

Table: DigitalMedia

Attributes: ItemID (PK, FK), Title (VARCHAR(255)), MediaType (VARCHAR(100)), Creator (VARCHAR(100)), Availability (BOOL)

Table: Magazine

Attributes: ItemID (PK, FK), Title (VARCHAR(255)), IssueNumber (INT), PublicationDate (INT), Status (BOOL)

Domains: PubYear $\in [1660, \text{CurrentYear}]$, where PubYear \leq CurrentYear

Table: Librarian

Attributes: LibrarianID (PK, INT), Name (VARCHAR(100)), Contact (VARCHAR(100)), Role (ENUM)

Domains: Role \rightarrow ENUM('Admin', 'Staff')

Table: Loan

Attributes: LoanID (PK, INT), MemberID (FK), ItemID (FK), ItemType (VARCHAR(50)), LoanDate (DATE), DueDate (DATE), ReturnDate (DATE), FineID (FK), LibrarianID (FK)

Domains: ItemType \rightarrow ENUM('Book', 'Magazine', 'DigitalMedia')

Table: Fine

Attributes: FineID (PK, INT), LoanID (FK), Amount (INT), PaymentStatus (ENUM)

Domains: PaymentStatus \rightarrow ENUM('Paid', 'Unpaid'), Amount ≥ 0

Table: Reservation

Attributes: ReservationID (PK, INT), MemberID (FK), ItemID (FK), ItemType (VARCHAR(50)), RequestDate (DATE), Status (BOOL)

Domains: ItemType \rightarrow ENUM('Book', 'Magazine', 'DigitalMedia'), Status \rightarrow BOOL (True/False)

4.3 Primary Keys

The tables are defined in section 4.2, and the corresponding primary keys are used as identifiers.

Table	Primary Key
Member	MemberID
MembershipType	TypeID
Item	ItemID
Book	ItemID
DigitalMedia	ItemID
Magazine	ItemID
Librarian	LibrarianID
Loan	LoanID
Fine	FineID
Reservation	ReservationID

4.4 Foreign Keys

The tables are defined in section 4.2, and the corresponding foreign keys are referenced.

Foreign Key	References
Member.TypeID	MembershipType.TypeID
Loan.MemberID	Member.MemberID
Loan.ItemID	Item.ItemID
Loan.FineID	Fine.FineID
Loan.LibrarianID	Librarian.LibrarianID
Fine.LoanID	Loan.LoanID
Reservation.MemberID	Member.MemberID
Reservation.ItemID	Item.ItemID
Book.ItemID	Item.ItemID
DigitalMedia.ItemID	Item.ItemID
Magazine.ItemID	Item.ItemID

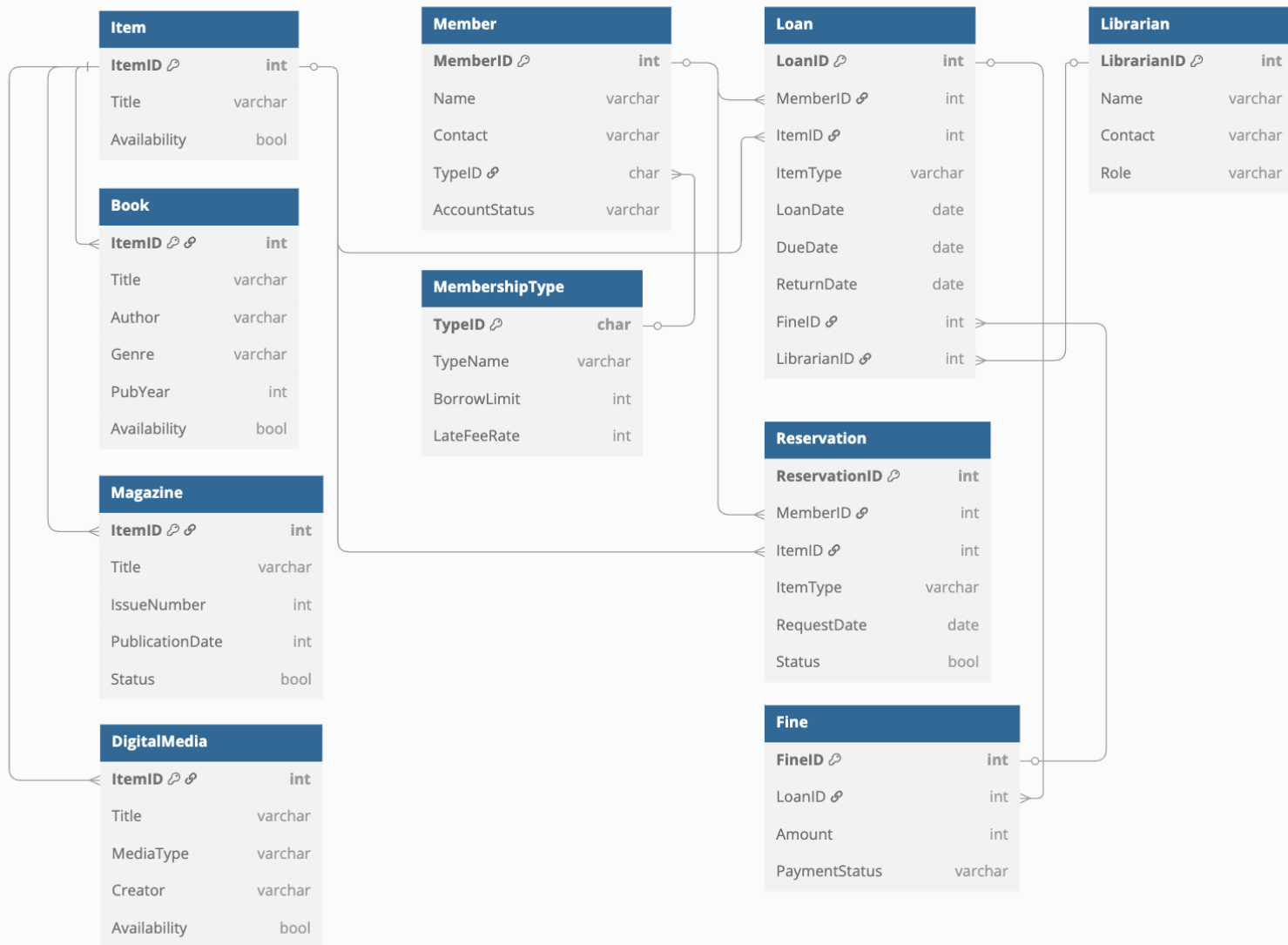
4.5 Functional Dependencies (FDs)

FD's represent the constraints from the real world, and are identified after the attribute that requires them. Descriptions of what these attributes are in the real world are in the data dictionary.

- MemberID \rightarrow Name, Contact, TypeID, AccountStatus
- TypeID \rightarrow TypeName, BorrowLimit, LateFeeRate
- ItemID \rightarrow Title, Availability
- Book.ItemID \rightarrow Author, Genre, PubYear
- LibrarianID \rightarrow Name, Contact, Role
- LoanID \rightarrow MemberID, ItemID, ItemType, LoanDate, DueDate, ReturnDate, FineID, LibrarianID
- FineID \rightarrow LoanID, Amount, PaymentStatus
- ReservationID \rightarrow MemberID, ItemID, ItemType, RequestDate, Status

5 Relational Schema Diagram and Data Dictionary

The relational schema diagram and data dictionary for the Library Management System (LMS) are provided on the following pages. These diagrams and definitions visually represent the relationships between various entities in the system, as well as the attributes and constraints for each entity.



Item	Attribute Name	Data Type	Description
	<u>ItemID</u>	INT	Identification number assigned to items in the library system.
	Title	VARCHAR(255)	Title of item in the library system.
	Availability	BOOL	Boolean value to denote if the item is available in the library sytem.
Book	Attribute Name	Data Type	Description
	<u>ItemID</u>	INT	Identification number assigned to book(s) in the library system. FK: Item
	Title	VARCHAR(255)	Title of book(s) in the library system.
	Author	VARCHAR(100)	Author of book(s) in library system.
	Genre	VARCHAR(50)	Genre of book(s) in library system.
	PubYear	INT	Year of publication for book(s) in library system.
	Availability	BOOL	Boolean value to denote if the book(s) are available in the library system.
Magazine	Attribute Name	Data Type	Description
	<u>ItemID</u>	INT	Identification number assigned to magazine(s) in the library system. FK: Item
	Title	VARCHAR(255)	Title of magazine(s) in the library system.
	IssueNumber	INT	Issue number of specified magazine(s) in the library system.
	PublicationDate	INT	Date that magazine issue was published.
	Status	BOOL	Current status of magazine(s) in the library system.
DigitalMedia	Attribute Name	Data Type	Description
	<u>ItemID</u>	INT	Identificaiton number assigned to digital media in the library system. FK: Item
	Title	VARCHAR(255)	Title of digital media in the library system.
	MediaType	VARCHAR(100)	Type of digital media in the library system.
	Creator	VARCHAR(100)	Name of creator of digital media in the library system.
	Availability	BOOL	Boolean value to denote if the digital media is available in the library system.
Member	Attribute Name	Data Type	Description
	<u>MemberID</u>	INT	Identification number assigned to member(s) in the library system.
	Name	VARCHAR(100)	Name of member in the library system.
	Contact	VARCHAR(100)	Contact information for member in the library system.
	TypeID	CHAR	Identification of type of membership member has in the library system. FK: MembershipType
	AccountStatus	ENUM	Status of member in the library system.
MembershipType	Attribute Name	Data Type	Description
	<u>TypeID</u>	CHAR	Identification of type of membership in the library system.
	TypeName	VARCHAR(100)	Name of the type of membership in the library system.
	BorrowLimit	INT	Limit of items allowed to be borrowed at a time, depending on membership type.
	LateFeeRate	INT	Rate of fees for late returns in the library system.
Loan	Attribute Name	Data Type	Description
	<u>LoanID</u>	INT	Identification number for loans of items in the library system.
	MemberID	INT	Identification number assigned to member in the library system. FK: Member
	ItemID	INT	Identification number assigned to items in the library system. FK: Item
	ItemType	VARCHAR(50)	Type of item in the library system.
	LoanDate	DATE	Date that an item loan is taken out of the library system.
	DueDate	DATE	Date that an item loan is due to be returned.
	ReturnDate	DATE	Date that an item that is loaned out is returned by the member.
	FineID	INT	Identification number for a fine corresponding to an overdue loan. FK: Fine
	LibrarianID	INT	Identification number of library employee who created the loan. FK: Librarian
Reservation	Attribute Name	Data Type	Description
	<u>ReservationID</u>	INT	Identification number assigned to a reservation made by a member.
	MemberID	INT	Identification number assigned to member in the library system. FK: Member
	ItemID	INT	Identification number assigned to items in the library system. FK: Item
	ItemType	VARCHAR(50)	Type of item in the library system.
	RequestDate	DATE	Date in which the reservation was created.
	Status	BOOL	Current status of the reservation.
Fine	Attribute Name	Data Type	Description
	<u>FineID</u>	INT	Identification number assigned to a loan that is overdue.
	LoanID	INT	Identification number for loan of items in the library system. FK: Loan
	Amount	INT	Amount due for the fine of an overdue loan.
	PaymentStatus	ENUM	Current status of the payment due for an overdue loan.
Librarian	Attribute Name	Data Type	Description
	<u>LibrarianID</u>	INT	Identificaiton number assigned to employee in the library system.
	Name	VARCHAR(100)	Name of the employee in the library system.
	Contact	VARCHAR(100)	Contact information for the employee in the library system.
	Role	ENUM	Administrative role of the employee in the library system.