Project Report

Big Data Management Analytics

ERD - LIBRARY MANAGEMENT SYSTEM

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Entity-Relationship Diagram - Library Management System

The ERD describes the database structure for a Library Management System, including entities, their attributes, primary keys (PK), foreign keys (FK), and relationships between tables.

Schema for the chosen database :

Authors, Publishers, and Categories: These lookup tables provide descriptive data used by Books.

Books and BookAuthors: A book can have one or more authors (handled by the BookAuthors join table), and each book is assigned one publisher and one category.

LibraryBranches and BookCopies: Instead of storing a single book record, the system tracks individual copies available at various branches.

Members, Loans, and Reservations: Members borrow book copies (Loans) and can also reserve a copy (Reservations).

Fines: When loans are overdue, fines are applied and linked back to both the member and the specific loan.

Librarians: Staff are tied to specific library branches.

BookReviews: Members can leave reviews for books they have read.

➔ **Schema Constraints and Optimizations**

- **Primary Keys (PK):** Ensures unique identification of records.
- **Foreign Keys (FK):** Maintains relationships between tables and enforces referential integrity.
- **Unique Constraints:**
    - `ISBN` in `Books` to prevent duplicate books.
    - `Email` in `Members` and `Librarians` to ensure unique user accounts.
- **Indexes:**
    - Index on `ISBN` in `Books` for executing faster lookups.
    - Index on `MemberID` in `Issue` and `Reservations` for quick member-related search.

➔ **Data Relationships and Indexing**

- **One-to-Many (1:M):** `Publishers → Books`, `Categories → Books`, `Books → BookCopies`, `LibraryBranches → BookCopies`
- **Many-to-Many (M:M):** `Books ↔ Authors (via BookAuthors)`, `Books ↔ Members (via BookReviews)`
- **Indexes:**
    - Index on `ISBN` in `Books` for executing fast searches.
    - Index on `Email` in `Members` and `Librarians` for quick authentication.
    - Index on `BookID` and `BranchID` in `BookCopies` for efficient book location search.

The schema efficiently supports library operations while enabling data-driven decision-making. The structured relationships help track book availability, member transactions, librarian management, and fine collection while ensuring data consistency and scalability.

1. Entities and Attributes

1.1 **Authors**

- Primary Key: AuthorID (INT)
- Attributes: FirstName (VARCHAR), LastName (VARCHAR), Bio (TEXT)

1.2 **Publishers**

- Primary Key: PublisherID (INT)
- Attributes: PublisherName (VARCHAR), Address (VARCHAR), Phone (VARCHAR)

1.3 **Categories**

- Primary Key: CategoryID (INT)
- Attributes: CategoryName (VARCHAR)

1.4 **Books**

- Primary Key: BookID (INT)
- Attributes: Title (VARCHAR), ISBN (VARCHAR), PublicationYear (INT), Summary (TEXT)
- Foreign Keys: PublisherID (INT), CategoryID (INT)

1.5 **Book Authors (Associative Table)**

- A join table that connects Books and Authors via a composite primary key (BookID, AuthorID)
- Primary Key: (BookID, AuthorID) **(Composite Key)**

- Foreign Keys: BookID (INT), AuthorID (INT)

1.6 **Library Branches**

- Primary Key: BranchID (INT)
- Attributes: BranchName (VARCHAR), Address (VARCHAR), Phone (VARCHAR)

1.7 **Book Copies**

- Tracks individual copies with CopyID, along with BookID, BranchID, and Status.
- Primary Key: CopyID (INT)
- Attributes: Status (VARCHAR)
- Foreign Keys: BookID (INT), BranchID (INT)

1.8 **Members**

- Primary Key: MemberID (INT)
- Attributes: FirstName (VARCHAR), LastName (VARCHAR), Email (VARCHAR), Phone (VARCHAR), Address (VARCHAR), MembershipDate (DATE)

1.9 **Issue (Borrowing Records)**

- Records book loans
- Primary Key: IssueID (INT)
- Attributes: LoanDate (DATE), DueDate (DATE), ReturnDate (DATE)
- Foreign Keys: CopyID (INT), MemberID (INT)

1.10 **Reservations**

- Logs reservations with ReservationID, CopyID, MemberID, ReservationDate, and Status.
- Primary Key: ReservationID (INT)
- Attributes: ReservationDate (DATE), Status (VARCHAR)
- Foreign Keys: CopyID (INT), MemberID (INT)

1.11 **Fines**

- Keeps fine records using FineID, MemberID, IssueID, Amount, DateIssued, and DatePaid.
- Primary Key: FineID (INT)
- Attributes: Amount (DECIMAL), DateIssued (DATE), DatePaid (DATE)
- Foreign Keys: MemberID (INT), IssueID (INT)

1.12 **Librarians**

- Lists LibrarianID, personal details, and the associated BranchID.
- Primary Key: LibrarianID (INT)
- Attributes: FirstName (VARCHAR), LastName (VARCHAR), Email (VARCHAR), Phone (VARCHAR)
- Foreign Key: BranchID (INT)

1.13 **Book Reviews**

- Allows members to review books with ReviewID, BookID, MemberID, Rating, Comment, and ReviewDate.
- Primary Key: ReviewID (INT)
- Attributes: Rating (INT), Comment (TEXT), ReviewDate (DATE)
- Foreign Keys: BookID (INT), MemberID (INT)

2. Relationships Between Tables

1. **Books & Publishers**
    - The Books table references Publishers.
    - A book is linked to one publisher (PublisherID in Books table).
    - A publisher publishes many books. (One-to-Many)
2. **Books & Categories**
    - A book is linked to a category (CategoryID in Books table).
    - A category contains many books. (One-to-Many)
3. **Books & Authors (Many-to-Many Relationship using BookAuthors table)**
    - A book can be written by multiple authors.
    - An author can write multiple books.
    - BookAuthors displays this many-to-many relationship.
4. **Library Branches & Book Copies**
    - Each BookCopy is associated with a LibraryBranch, indicating the physical location.
    - A branch contains multiple copies of books.
    - A book copy belongs to a specific branch. (One-to-Many)
5. **Book Copies & Issue (Borrowing)**
    - Members can issue (loan) books, reserve copies, and have fines recorded against specific issues.
    - A book copy can be issued to a member.

- An issue refers to a single book copy. (One-to-Many)

6. **Members & Issue**
   - A member can borrow multiple books.
   - An issue is linked to one member. (One-to-Many)
7. **Book Copies & Reservations**
   - A book copy can be reserved by multiple members.
   - A reservation belongs to one copy. (One-to-Many)
8. **Issue & Fines**
   - A fine is related to a specific issue.
   - A member may have multiple fines. (One-to-Many)
9. **Librarians & Library Branches**
   - Librarians are linked to their respective branches.
   - A librarian works at one branch.
   - A branch can have multiple librarians. (One-to-Many)
10. **Book Reviews & Books**
    - Connects Books and Members, indicating which member wrote a review for which book.
    - A book can have multiple reviews.
    - A review belongs to a single book. (One-to-Many)
11. **Book Reviews & Members**
    - A member can write multiple reviews.
    - A review is written by one member. (One-to-Many)

The diagram also displays relationship labels such as "belongs_to," "relates_to," "involves," "refers_to," "works_at," "reviews," and "written_by." These are meant to describe how the entities interact.

3. Primary and Foreign Key Table

Entity	Primary Key (PK)	Foreign Keys (FK)
Authors	AuthorID	-
Publishers	PublisherID	-
Categories	CategoryID	-
Books	BookID	PublisherID, CategoryID
BookAuthors	BookID, AuthorID	BookID, AuthorID
LibraryBranches	BranchID	-
BookCopies	CopyID	BookID, BranchID
Members	MemberID	-
Issue	IssueID	CopyID, MemberID
Reservations	ReservationID	CopyID, MemberID
Fines	FineID	MemberID, IssueID
Librarians	LibrarianID	BranchID
BookReviews	ReviewID	BookID, MemberID

4. ERD Diagram