Project Overview: Library Management System

EECS447: Database Systems
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Project Goal: This project aims to provide hands-on experience in designing, implementing, and managing a relational database system for a small library. The system will manage a diverse collection of loanable items, track various types of memberships, enforce borrowing rules, and generate meaningful reports.

The following provides an overview of the project. *Detailed information regarding each milestone, deliverable, due dates, and point allocation will be available on Canvas.*

Project Phases and Deliverables

1. Vision Statement and Project Plan: Explain why you are developing the library database product. Define the scope of the project, indicating what will be completed. Also, define the team organization and team member roles (also include a profile for each team member). Decide on weekly meeting details, e.g., the location, schedule, and methods for task allocation and tracking. Decide on how to manage the team GitHub repository. Ensure all project artifacts are maintained there.

2. Domain Modeling and Requirements Rngineering. Brainstorm about the entitles, relationships, requirements, and constraints in a typical library domain. For example,

- Each book and digital media item should have attributes such as title, author/creator, ISBN, publication year, genre, and availability status.
- Magazines should include title, issue number, publication date, and availability status.
- Clients should have a unique ID, name, contact information, membership type, and account status.
- Several categories of members (e.g., regular, students, senior citizens, etc.) may exist.
- Membership types will determine borrowing limits and fee structures.
- Identify constraints, for example, each client can borrow a maximum number of items at a time, depending on their membership type; fees are incurred for late returns, with different rates based on the membership type; certain items (e.g., rare books or latest issues of magazines) may have borrowing restrictions, etc.
- Track all borrowing and returning transactions, including timestamps and responsible clients.
- Allow clients to reserve books that are currently on loan.

- Implement a notification system for upcoming due dates, overdue items, and available reserved items.
- Ensure the system can generate various reports, such as fine calculations, book availability, borrowing trends, and client activity.

Review the sample queries and reports at the bottom as they may suggest additional entities and relationships to be included in the database.

You may consider designing two user interfaces for the following roles:

- **Library staff:** Interface to check out items, process returns, add new items, and manage client accounts.
- **Clients:** Interface to search the catalog, reserve items, check loan status, and such.

3. Conceptual Design

Develop a conceptual model using ER diagrams. Make sure all entities, relationships, entity and relationship attributes, key attributes, etc. are clearly identified and illustrated.

4. Logical Design

Convert the E-R model into a set of relations. For each relationship, clearly indicate the relation names, attributes, attribute types, primary key attributes, foreign key attributes, and functional dependencies. Normalize the relations to 3NF or BCNF. Define all important referential integrity constraints.

5. Physical Design and Data Population

Use SQL DDL to design your database. Contemplate check constraints (for example, to ensure fees are non-negative and borrowing limits are not exceeded). Also contemplate triggers, for example, to automatically calculate late fees and update the availability status of items.

Populate the database with a realistic set of data: at least 20 books, 20 digital media items, 20 magazines, and 50 client records, etc. Include a variety of membership types and associated borrowing records. Randomly generate some of the data to ensure diversity in loans, fees, and reservations.

Ensure that no item is borrowed beyond its due date without generating a late fee. Ensure each client adheres to the borrowing limits set by their membership type.

6. Project Demonstration

Examples of Queries

The following are some example queries that I have devised. For your implementation demo, you may want to run queries like these. You are welcome and encouraged to devise more intriguing and unique SQL queries . In essence, the following can be seen as *requirement* guidelines for designing a database.

- **List all books by a specific author**: Display all books in the library collection written by a particular author.
- **Find books by publication year**: Retrieve a list of books published in a specific year.
- **Check membership status**: Display the current status and account information for a specific client based on their unique ID.
- **Fine calculation**: Calculate the total fines owed by each member, considering overdue books and a daily fine rate (e.g., $0.25 per day).
- **Book availability**: Display a list of all available books (not currently borrowed) within a specific genre.
- **Frequent borrowers of a specific genre**: Identify the members who have borrowed the most books in a particular genre (e.g., "Mystery") in the last year.
- **Books due soon**: Generate a report of all books due within the next week, sorted by due date.
- **Members with overdue books**: List all members who currently have at least one overdue book, along with the titles of the overdue books.
- **Average borrowing time**: Calculate the average number of days members borrow books for a specific genre.
- **Most popular author in the last month**: Determine the author whose books have been borrowed the most in the last month.
- **Monthly fees report**: Generate a report of total fees collected within the last month, broken down by membership type.
- **Exceeded borrowing limits**: Produce a list of clients who have exceeded their borrowing limits.
- **Frequent borrowed items by client type**: Determine the most frequently borrowed items by each client type.
- **Never late returns**: Find out which clients have never returned an item late.
- **Average loan duration**: Calculate the average time an item stays on loan before being returned.
- **Monthly summary report**: Generate a report summarizing the total number of items loaned, total fees collected, and most popular items for the month.
- **Statistics breakdown**: Breakdown the statistics by client type and item category (books, digital media, magazines).
- **Client borrowing report**: Produce an individual report for each client showing their borrowing history, outstanding fees, and any reserved items.

- **Item availability and history**: List all items, their current availability status, and their last borrowed date. Highlight items that have not been borrowed in the past six months.
- **Overdue items report**: Generate a report listing all overdue items, the client responsible, and the calculated late fees.
- **Revenue summary**: Summarize the library's revenue from fees, showing the breakdown by membership type and item category.

Examples of Reports

Consider generating at least one elaborate report. The following are some suggestions.

- **Generate a collection analysis report.** This report should provide a comprehensive analysis of the library's book collection, examining the distribution of books by genre, identifying trends in acquisition over the past 5 years, and assessing the age of the collection to identify outdated materials. Highlight books with low circulation and analyze borrowing patterns to identify under-represented genres or authors. Your report should provide insights for collection development and management decisions. The steps for creating such a report may include:

  - Use GROUP BY with genre to analyze the distribution of books.
  - Use COUNT(*) and GROUP BY with publication year to identify acquisition trends.
  - Use AVG(YEAR(CURDATE( )) – publication year) to calculate the average age of books.
  - Use a subquery or NOT EXISTS to find books with zero borrows.

- **Generate a member engagement report**. This report should evaluate how library members interact with the library's resources and services. Track membership growth over the past year, analyze member demographics, and examine borrowing behavior to understand member preferences and identify "power users." Your findings should inform strategies for improving member engagement and tailoring library services. The steps for creating such a report may include:

  - Use COUNT(*) and GROUP BY with registration date to track membership growth.

- ❖ Use aggregate functions and **GROUP BY** with demographic information (e.g., age, location) to analyze member demographics.
- ❖ Use **COUNT(*)** and **GROUP BY** with member id to find "power users."
- ❖ Join **Borrowing** and **Books** tables to analyze borrowing preferences by genre or author.

- **Generate an operational efficiency report.** This report should assess the library's operational effectiveness. Analyze key metrics such as book loan and return processing times, overdue book rates, and fine collection trends. Identify peak borrowing periods to optimize staffing levels and pinpoint potential bottlenecks in library processes to improve overall efficiency and service delivery. The steps for creating such a report may include:
  - ❖ Use **AVG(DATEDIFF(return_date, borrow_date))** to calculate average borrowing time.
  - ❖ Use **COUNT(*)** and **WHERE** clauses with date conditions to calculate overdue book rates.
  - ❖ Use **SUM(fines)** and **GROUP BY** with time periods to analyze fine collection trends.
  - ❖ Use **COUNT(*)** and **GROUP BY** with borrow date to identify peak borrowing hours and days.