

BOOKSTORE DATABASE MANAGEMENT SYSTEM REPORT

Look Inna Book Inc.

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1. Problem Statement

Design and implement an application for an online bookstore (Look Inna Book). This application lets users browse a collection of books that are available in the bookstore. A user can search the bookstore by book name, author name, ISBN, genre, etc. When a book is selected, information on the author(s), genre(s), publisher, number of pages, price, etc. can be viewed. A user can select as many books as she likes to be added to the checkout basket. A user needs to be registered in the bookstore to be able to checkout. When checking out, the user inserts billing and shipping information (can be different than those used in registration) and completes the order. The bookstore has the feature of tracking an order via an order number. A user can use this order number to track where the order is currently. Although shipping is carried out by a third-party shipping service, the online bookstore should have the tracking information available for when the user inquires about an order using the order number. Assume all books are shipped from only one warehouse (no multiple order numbers for multiple books shipped from multiple warehouses). The bookstore owners can add new books to their collections or remove books from their store. They also need to store information on the publishers of books such as name, address, email address, phone number(s), banking account, etc. The banking account for publishers is used to transfer a percentage of the sales of books published by these publishers. This percentage is variable and changes from one book to another. The owners should have access to reports that show sales vs. expenditures, sales per genres, sales per author, etc. The application should also be able to automatically place orders for new books if the remaining quantity is less than a given threshold (e.g., 10 books). This is done by sending an email to the publisher of the limited books to order several books equal to how many books were sold in the previous month(not required).

2. Conceptual Design

Before designing the ER-diagram and Relation Schemas, it should be clearer to first make appropriate assumptions, list the entities and summarize the relationships based on the problem statement above.

2.1 Entities

- Book: name, author(s), ISBN, genre(s), numPages, cost, price, stock, royalty, threshold, total_stocked
- User: username, password, fname, lname, address
- Order: order_id, shipping_address, billing_address, tracking_info
- Publisher: pub_name, address, email, phone(s), bank_account

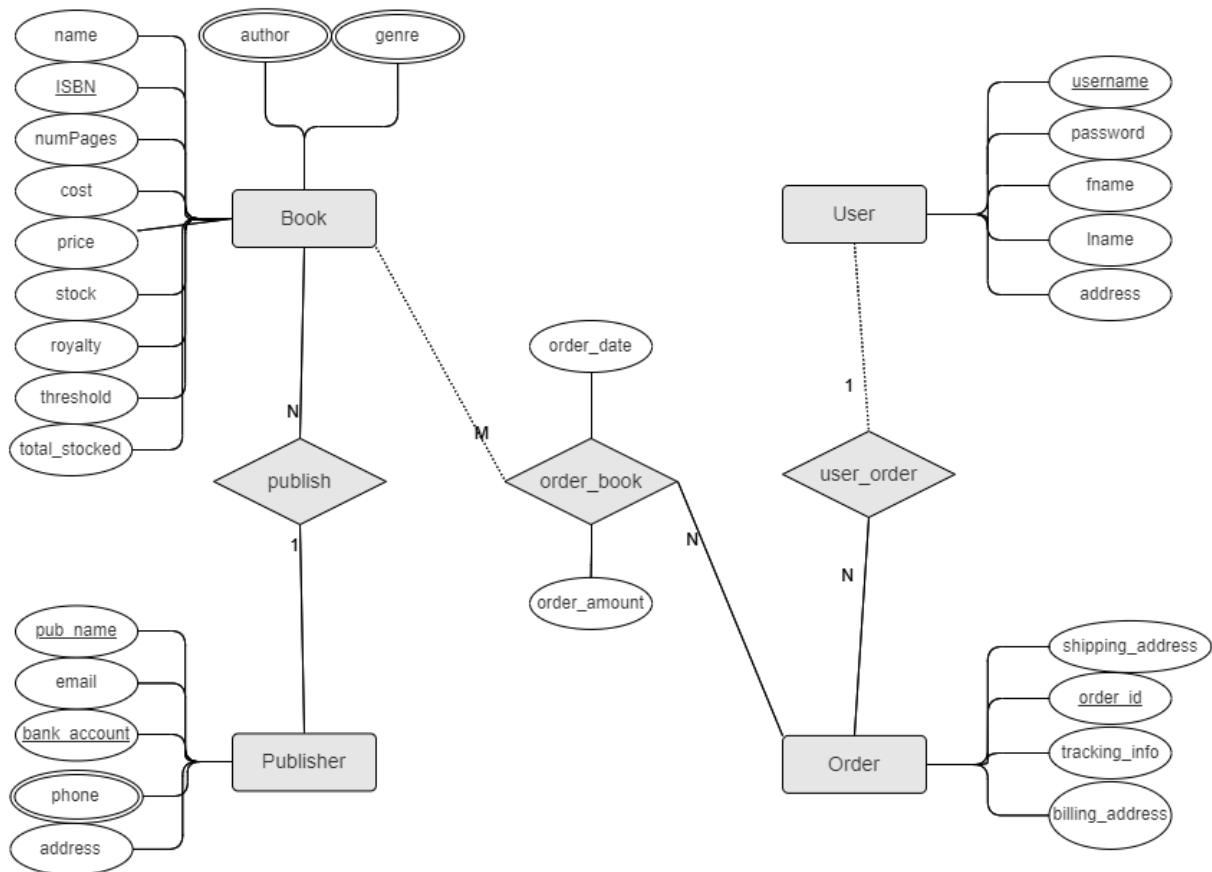
2.2 Relationships and Assumptions

- Publish: A book can only have 1 publisher, and a publisher can publish 1 to N books
 - Publisher (1, total participation): Book (N, total participation)
 - ⇒ No need for a new table, add publisher_fk to Book table
- User_Order: A user can place 0 to N orders, and each order is associated with 1 user
 - User (1, partial participation): Order (N, total participation)
 - ⇒ No need for a new table, add user_fk to Order table
- Order_Book: an order can have 1 to N books, each book can be associated with 0 to M orders
 - Order (M, total participation): Book (N, partial participation)
 - ⇒ Need a new table, also add an order_amount for each book and order_date

Now, it's clear to draw an ER Diagram based on the above entities, relationships, and assumptions.

2.3 ER Diagram (Chen Notation)

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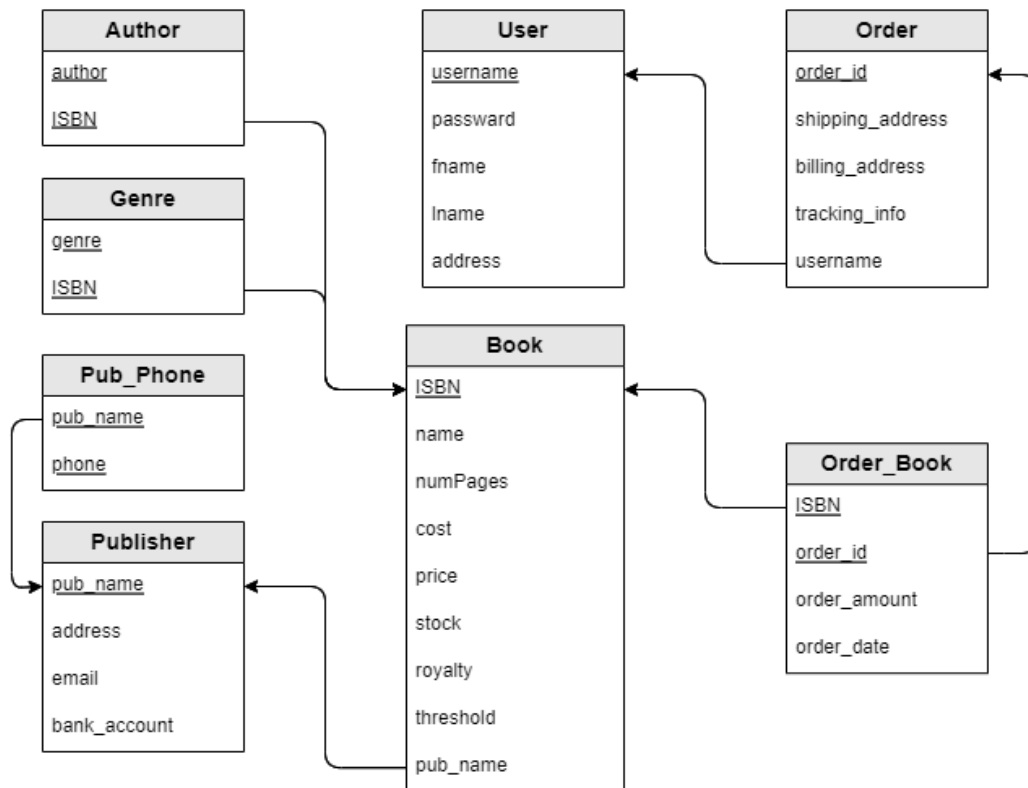


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2.4 Reduction to Relation Schemas

- Book (ISBN, name, numPages, cost, price, stock, royalty, threshold, pub_name)
- Author (author, ISBN)
- Genre (genre, ISBN)
- User (username, password, fname, lname, address)
- Publisher (pub_name, address, email, bank_account)
- Pub_Phone (pub_name, phone)
- Order (order_id, shipping_address, billing_address, tracking_info, username)
- Order_Book: (ISBN, order_id, order_amount, order_date)

Relation Schema diagram v1 before normalization test is also shown in the next page.



3. Normalization of Relation Schemas

3.1 Normalization Test for Each Relation

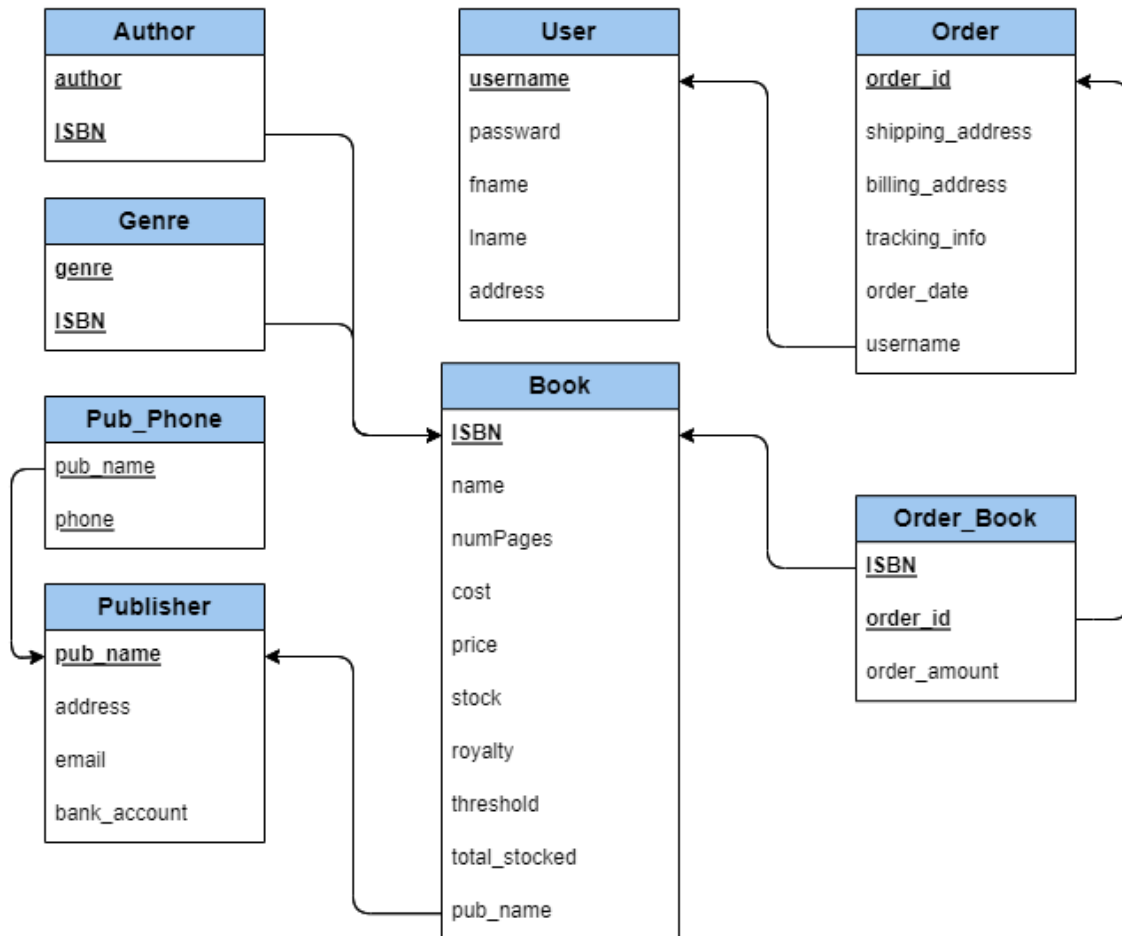
- **Book** (ISBN, name, numPages, cost, price, stock, royalty, threshold, total_stocked, pub_name)
 - $F =$
 - {
 - ISBN \rightarrow name, numPages, cost, price, stock, royalty, threshold, total_stocked, pub_name
 - }
 - $(ISBN \cup RHS) = R$
 - \Rightarrow ISBN is a superkey
 - Function dependencies that are derived from augmentation rules and decomposition rules all have LHS as a superkey, and all other function dependencies are all trivial.
 - \Rightarrow this relation is in BCNF
- **Author** (author, ISBN)
 - $F =$
 - {
 - author, ISBN \rightarrow ISBN
 - author, ISBN \rightarrow author
 - }

- All function dependencies are trivial, and LHS is a superkey
 \Rightarrow This relation is in BCNF
- Genre (genre, ISBN)
 - $F =$
 - {
 - genre, ISBN \rightarrow ISBN
 - genre, ISBN \rightarrow genre
 - }
 - All function dependencies are trivial, and LHS is a superkey
 \Rightarrow This relation is in BCNF
- User (username, password, fname, lname, address)
 - Multiple users are allowed to register on the same address, so the address can not determine the user.
 - $F =$
 - {
 - username \rightarrow password, fname, lname, address
 - }
 - $(\text{username} \cup \text{password, fname, lname, address}) = R$
 \Rightarrow username is a superkey
 - Function dependencies that are derived from augmentation rules and decomposition rules all have LHS as a superkey, and all other function dependencies are all trivial.
 \Rightarrow this relation is in BCNF
- Publisher (pub_name, address, email, bank_account)
 - Different businesses can share an address or an email, but they should have different bank account. That is to say, the bank account uniquely determines publisher.
 - $F =$
 - {
 - pub_name \rightarrow address, email, bank_account
 - bank_account \rightarrow pub_name
 - }
 - Other function dependencies are all trivial
 - $\text{bank_account}^+ = \{\text{pub_name, address, email, bank_account}\}$
 \Rightarrow pub_name and bank_account are superkeys
 - Function dependencies that are derived from augmentation rules and decomposition rules all have LHS as a superkey, and all other function dependencies are all trivial.
 \Rightarrow this relation is in BCNF
- Pub_Phone (pub_name, phone)
 - $F =$
 - {
 - pub_name, phone \rightarrow pub_name
 - pub_name, phone \rightarrow phone
 - }
 - All function dependencies are trivial, and LHS is a superkey
 \Rightarrow This relation is in BCNF

- Order (order_id, shipping_address, billing_address, tracking_info, username)
 - Since shipping address and billing address can be different than the address used for registration, username can not determine the address used in an order.
 - $F =$
 - {
 - $\text{order_id} \rightarrow \text{shipping_address}, \text{billing_address}, \text{tracking_info}, \text{username}$
 - }
 - $(\text{order_id} \cup \text{shipping_address}, \text{billing_address}, \text{tracking_info}, \text{username}) = R$
 - \Rightarrow order_id is a superkey
 - Function dependencies that are derived from augmentation rules and decomposition rules all have LHS as a superkey, and all other function dependencies are all trivial.
 - \Rightarrow this relation is in BCNF
- Order_Book: (ISBN, order_id, order_amount, order_date)
 - $F =$
 - {
 - $\text{ISBN}, \text{order_id} \rightarrow \text{order_amount}, \text{order_date}$
 - $\text{order_id} \rightarrow \text{order_date}$
 - }
 - $\text{order_id}^+ = \{\text{order_id}, \text{order_date}\}$
 - \Rightarrow order_id is not a superkey, this relation is NOT in BCNF
 - \Rightarrow BCNF Decomposition:
 - OrderDate(order_id, order_date)
 - Order_Book(ISBN, order_id, order_amount)
- Order_Book: (ISBN, order_id, order_amount)
 - $F =$
 - {
 - $\text{ISBN}, \text{order_id} \rightarrow \text{order_amount}$
 - }
 - $(\text{ISBN}, \text{order_id} \cup \text{order_amount}) = R \Rightarrow$ LHS is a superkey
 - Function dependencies that are derived from augmentation rules and decomposition rules all have LHS as a superkey, and all other function dependencies are all trivial.
 - \Rightarrow this relation is in BCNF
- OrderDate(order_id, order_date)
 - This relation has composite relationship with Order because its PK is pointing to Order's PK, and it's considered as a part of the Order. Every time the records are deleted/added when the correspondences are deleted/added in Order table.
 - Need to composite this relation into Order relation, and run BCNF test again on Order
- Order (order_id, shipping_address, billing_address, tracking_info, username, order_date)
 - $F =$ {
 - $\text{order_id} \rightarrow \text{shipping_address}, \text{billing_address}, \text{tracking_info}, \text{username}$
 - \Rightarrow order_id is a superkey
 - Function dependencies that are derived from augmentation rules and decomposition rules all have LHS as a superkey, and all other function dependencies are all trivial.
 - \Rightarrow this relation is in BCNF

3.2 Database Schema Diagram After Normalization

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4. Implementation

4.1 Languages, frameworks, and software

- Programming languages: C++, SQL
- Frameworks and Tools: QT(5.12.8 GCC 9.3.0 64 bit), QT Creator(4.11.0), QT Designer, QT SQL, SQLite(3.31.1)

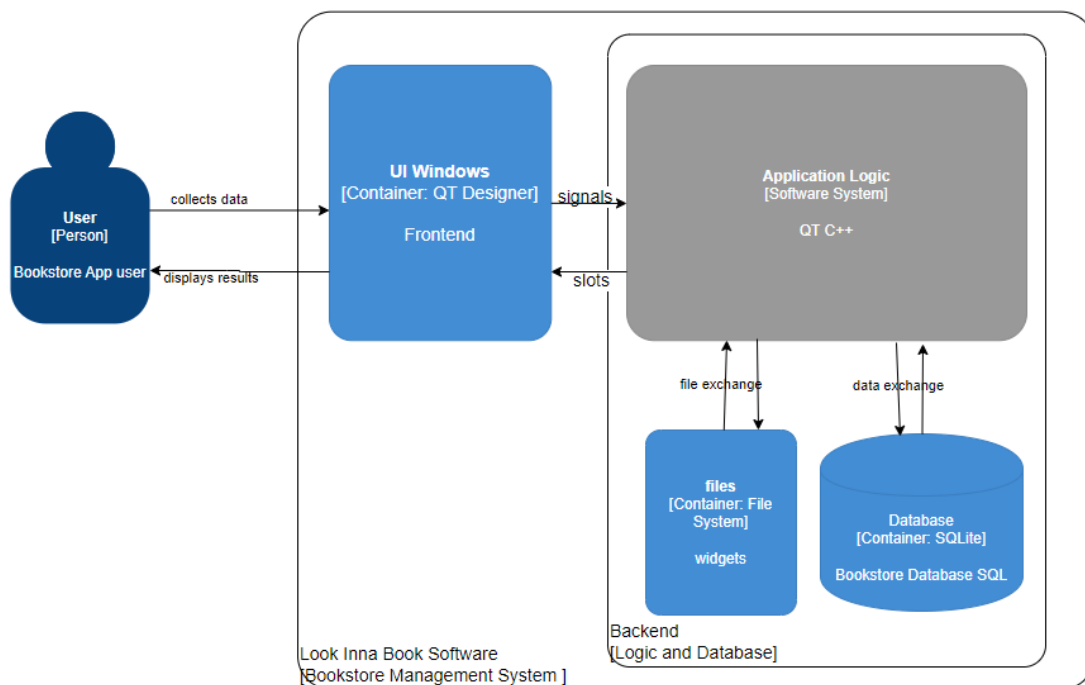
Note that the QT SQL module uses driver plugins to communicate with the different database APIs. SQLite version 3 is included as a third-party library within Qt, you can connect to SQLite database engine without hosting a database server. SQLite operates on a single file, which must be set as the database name when opening a connection. If the file does not exist, SQLite will try to create it.

Since we don't need to host a database server, it makes SQLite a great choice for the purpose of making this bookstore management system very lightweight and easy to test. However, please be aware that the datatypes in SQLite are different than other traditional SQL databases management systems. The

datatypes used in this project is compatible with SQLite only. Each value stored in an SQLite database has one of the following storage classes:

1. NULL. The value is a NULL value.
2. INTEGER. The value is a signed integer, stored in 0, 1, 2, 3, 4, 6, or 8 bytes depending on the magnitude of the value.
3. REAL. The value is a floating-point value, stored as an 8-byte IEEE floating point number.
4. TEXT. The value is a text string, stored using the database encoding (varchar, char, etc.).
5. BLOB. The value is a blob of data, stored exactly as it was input.

4.2 Application Architecture



- UI Windows:
 - Forms(xml):
 - mainwindow.ui
 - login, admin login, register
 - browse/search/sort books, place order, track order
 - adminwindow.ui
 - add/remove books
 - generate report

- Application Logic:
 - MainWindow class (control/boundary): has AdminWindow class
 - Establishes connection with the database
 - Initializes database tables and generates dummy data
 - Handles all user's requests (UI events)
 - Exchanges data with the database
 - Opens AdminWindow on request
 - AdminWindow class (control/boundary):
 - Establishes connection with the database
 - Handles admin's requests (UI events)
 - Exchanges data with the database
- Database:
 - In addition to the eight tables that are shown in the last section, there are one sqlite_sequence system table, 2 views and 3 triggers:
 - sqlite_sequence: system table to keep track of autoincrement primary key for the order table
 - table_view: list all books with genres and authors
 - report_view: list price and sales info group by books
 - restock_book: restocks 30 books if the stock is lower than the threshold
 - init_total_stocked: initialize total_stocked when insert new book
 - update_total_stocked: update total_stocked when the bookstore makes a purchase to stock more books
 - Dummy data are inserted at the start of the application.
 - You can login as a user using
 - Username: student
 - Password: student
 - You can login as an administrator using
 - Username: admin
 - Password: admin

4.3 User Screens

- Login

Username	<input type="text" value="student"/>	Username	<input type="text" value="admin"/>
Password	<input type="text" value="student"/>	Password	<input type="text" value="admin"/>
	<input type="button" value="Login"/>		<input type="button" value="Admin Login"/>

- Register

Sign up to use our online services!

Username

Password

First Name

Last Name

Home Address

- Landing page

Welcome to Look Inna Book

User Login Admin Login Register Landing Browse Shopping Cart Tracking

Welcome to Look-Inna Book

Login to order online!

Username

Password

student logged in successfully!

- Browse and search

Welcome to Look Inna Book

User Login Admin Login Register

Landing Browse Shopping Cart Tracking

Search by: genre Sort By best sellers last month

Search novel Sort

	ISBN	name	price	publisher	authors	genres	pages
1	0-1104-5785-4	Shang-Chi and...	29.95	Marvel Comics	Sam Lee	fiction	155
2	0-1144-0720-7	Apollo 11: ...	30.05	Simon & ...	Diana ...	narrative,non-...	360
3	0-1704-1348-9	Intro to Calcul...	46.95	Pearson ...	Alysha ...	textbook	450
4	0-3774-7473-8	Ender's Game ...	28	Marvel Comics	Orson S. Card	comics,fiction	252
5	0-4468-4857-3	Star Wars: ...	29.95	Marvel Comics	John Wall,Kevi...	fiction	230
6	0-5287-4530-1	The Moonlight	25.95	Continent Inc.	Ned Dawson	non-...	390
7	0-5464-5226-4	Pre-Calculus 1...	159	Pearson ...	Rufus Ali	textbook	655
8	0-6257-1942-5	Intro to Calcul...	49.95	Pearson ...	Alysha ...	textbook	550
9	0-8075-3873-6	Ten Things We...	23	Continent Inc.	Amirah Lyons	non-...	290
10	0-8472-7748-8	The Hating ...	30	Simon & ...	Sally Thorne	romance novel	386
11	0-8521-1367-6	Star Wars: ...	24.5	Marvel Comics	John Wall,May...	fiction	178

Add to cart select the book that you'd like to buy, then click "Add to card" button, adjust order amount in the cart

student logged in successfully!

- Shopping cart and place order

Welcome to Look Inna Book

User Login Admin Login Register

Landing Browse Shopping Cart Tracking

Shopping cart for : student

	ISBN	Name	Price	Amount
1	0-1104-5785-4	Shang-Chi and the Ten ...	29.95	3
2	0-1144-0720-7	Apollo 11: Landing on ...	30.05	4
3	0-1704-1348-9	Intro to Calculus II	46.95	1
4	0-3774-7473-8	Ender's Game (comics)	28	7

If you'd like to remove the item, just set the amount to zero

Shipping Address my address Billing Address billing address

Place Order Total price: \$453

student logged in successfully!

- Tracking an order

Welcome to Look Inna Book

User Login Admin Login Register Landing Browse Shopping Cart Tracking

Order ID 1

Track

	order placed on	order id	shipped to	tracking
1	2022-11-29	1	8355 Williams St.Vista, C...	Order shipped

Username student

Password student

Login

student logged in successfully!

- Admin Window – Add/remove books

AdminWindow

Manage Books Sales Report

Add Book Remove Book

ISBN Pages

Name Stock

Cost Price

Royalty IN (0, 1) Threshold

☐ New Publisher? ☐ Choose existing publisher

Publisher Name Publisher Email

Publisher Address Publisher Phone 1

Publisher Phone 2 Publisher Bank Account

Author1 Author2

Genre1 Genre2

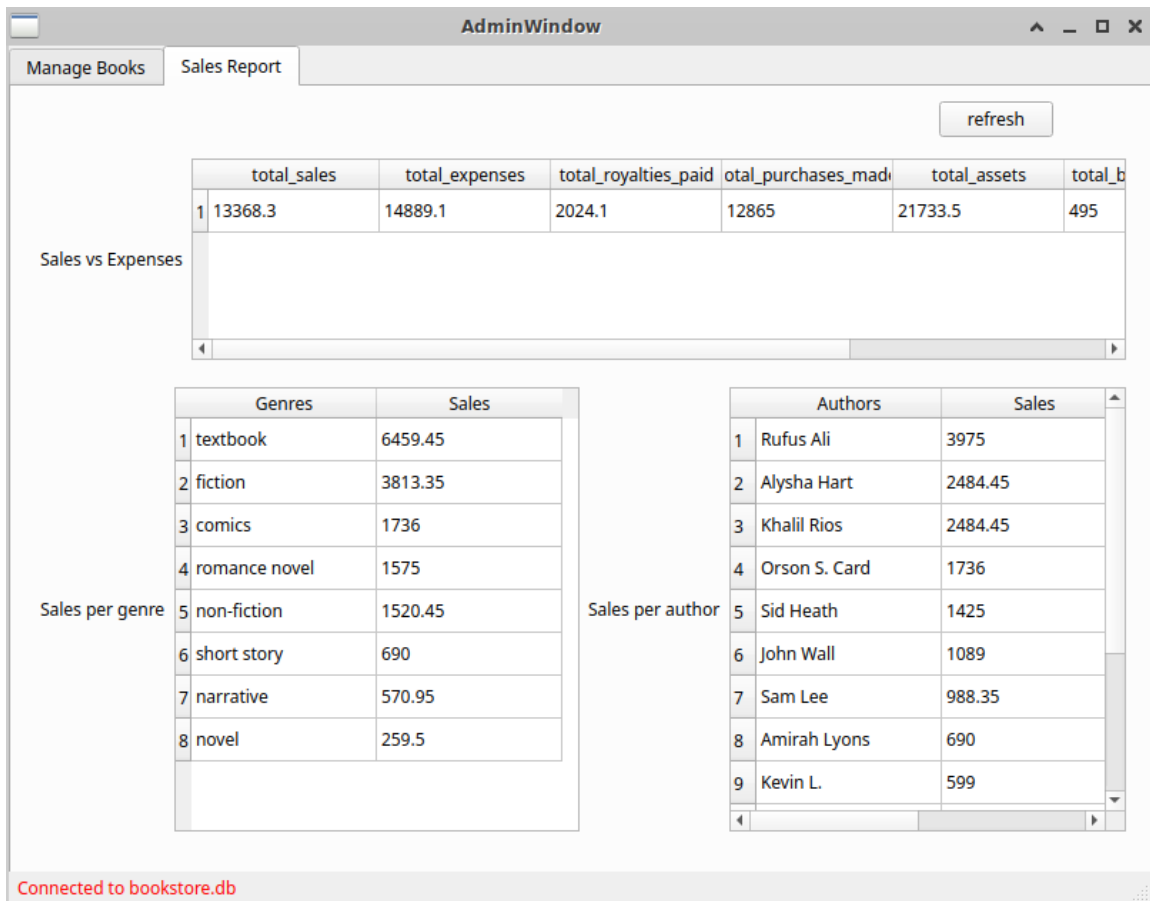
Add Book If publisher is new, then adding book will add publisher as well

Enter the ISBN to remove:

Remove Book

Connected to bookstore.db

- Sales report



4.4 Bonus Features


- Approximate search

The Shopping interface includes tabs for 'Landing', 'Browse', 'Shopping Cart', and 'Tracking'. The search section has the following elements:

- Search by:** A dropdown menu currently set to 'book name'.
- Sort By:** A dropdown menu currently set to 'best sellers last month'.
- Search:** A button next to a text input field containing 'us'.
- Sort:** A button.

Below the search section is a table of search results:

	ISBN	name	price	publisher	authors	genres
1	0-1704-1348-9	Intro to Calculus II	46.95	Pearson Education	Alysha Hart, Khalil Rios	textbook
2	0-5464-5226-4	Pre-Calculus 12 Student ...	159	Pearson Education	Rufus Ali	textbook
3	0-6257-1942-5	Intro to Calculus I	49.95	Pearson Education	Alysha Hart, Khalil Rios	textbook

- 

- | | total_sales | total_expenses | total_royalties_paid | total_purchases_made | total_assets | total_book_income | total_book_sold |
|---|-------------|----------------|----------------------|----------------------|--------------|-------------------|-----------------|
| 1 | 13368.3 | 14889.1 | 2024.1 | 12865 | 21733.5 | 495 | 325 |
| | | | | | | | |
| | | | | | | | |

<https://github.com/addiexx1/Look-Inna-Book->