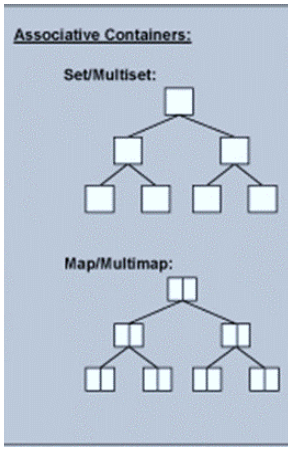
CPSC 131, Data Structures – Fall 2022
Homework 4: Ordered Associative Containers

Learning Goals:

- Familiarization and practice with key/value association data structure usage and binary search tree concepts
- Familiarization and practice using the same key across associative containers to join the contents into a single view
- Familiarization and practice using the STL's map container interface
- Reinforce the similarities and differences between sequence and associative containers
- Reinforce reading persistent data from disk files and storing in memory resident data structures
- Reinforce modern C++ object-oriented programming techniques



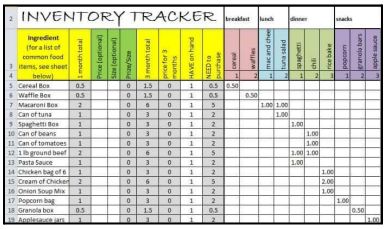
Description:

This Bookstore Inventory project builds on the Book, Book Cart, and Book Database from previous assignments by adding the maintenance of a bookstore's inventory at the checkout counter. Here you are given a collection of customers (e.g., Woodstock, Lucy, Carlie) pushing their shopping cart, each already filled with the books from their shopping list. Each customer goes through the checkout line where the books are scanned and a receipt is given. As books are scanned, the store's inventory is updated by reducing the number of books on hand for that book.

At the end of the day after all customers have been processed, you take inventory and reorder books that are getting low.

You are provided with starter code that together with your work from previous assignments form your point of departure to complete this assignment.

1. **main.cpp** – Function main() orchestrates the flow of execution. A partial implementation has been provided. You are to complete the implementation.



2. **Book.hpp/Book.cpp** – Reuse the Book class from your previous assignments. Unless you find an error or omission in your code, these files should require no modification.

3. **BookDatabase.hpp/BookDatabase.cpp** – A partial implementation of the BookDatabase class has been provided. The previous assignment used the sequential container std::vector for the memory resident database. This assignment uses the associative container std::map, a binary search tree, associating an ISBN with a book. An updated (from the last assignment) BookDatabase.hpp incorporating this change is provided and requires no modifications. You are to modify BookDatabase.cpp by completing the implementation. Leverage the code you wrote in the last assignment making adjustments for std::map vice std::vector. Function find(), for example, will no longer be implemented as a recursive linear search function. Instead, it should delegate to the map's binary search function find().

4. **Bookstore.hpp/Bookstore.cpp** – A partial implementation of the Bookstore class has been provided. You are to complete the implementation. Bookstore.hpp requires no modifications. You are to modify Bookstore.cpp by completing the implementation.

   a. Bookstore constructor – This function takes as a parameter the name of store's inventory database file containing pairs of ISBN and quantity, each pair on a separate line. Populate the store's inventory database with the contents of the file. For example, the contents of "BookstoreInventory.dat" may look like:

   ```
   0051600080015   36
   0019600923015   34
   0688267141676   36
   0657622604842   25
   ```

   In this assignment, there are two text files used to persist data. Don't confuse this file (BookstoreInventory.dat) that persists a store's inventory with the file (Open Library Database-Large.dat) used by class BookDatabase above that persists the full description and price of a book. Both use the ISBN as the key but contain quite different information.

   b. getInventory – This function takes no arguments and returns a reference to the store's inventory database. The inventory, designed as a binary search tree and implemented using the STL's map class, is an association between ISBN (the key) and the quantity on hand (the value). As a convenience, an alias called Inventory_DB has been created as part of the Bookstore interface in Bookstore.hpp. *Use this alias* in your work everywhere as appropriate.

   c. ringUpAllCustomers – This function takes a collection of shopping carts (i.e., a collection of customers with their shopping cart) as a parameter and returns a collection of unique ISBNs for books that have been sold. Pretend you have a lot of customers waiting in line to purchase the books in their cart. Ring up each customer individually while accumulating the books sold. As a convenience, aliases called BooksSold, ShoppingCart and ShoppingCarts have been created as part of the Bookstore interface in Bookstore.hpp. *Use these aliases* in your work everywhere as appropriate.

   d. ringUpCustomer – This function takes a shopping cart as a parameter and returns a collection of ISBNs of purchased by this customer. Scan all the books in their shopping cart, print a receipt with an amount due, and deduct the books purchased from the store's inventory. The logic to scan books and print a receipt should be carried forward from your last assignment. Look at last assignment's posted solution if you need help. Add the book to the collection of books purchased.

   e. reorderBooks – This function takes a collection of ISBNs for books sold as a parameter and returns nothing. For each book sold, check the store's inventory for the quantity on hand. If there are less than 15 books, print a message indicating the current number on hand then order 20 more by adding 20 to the current number on hand. A sample report might look like:

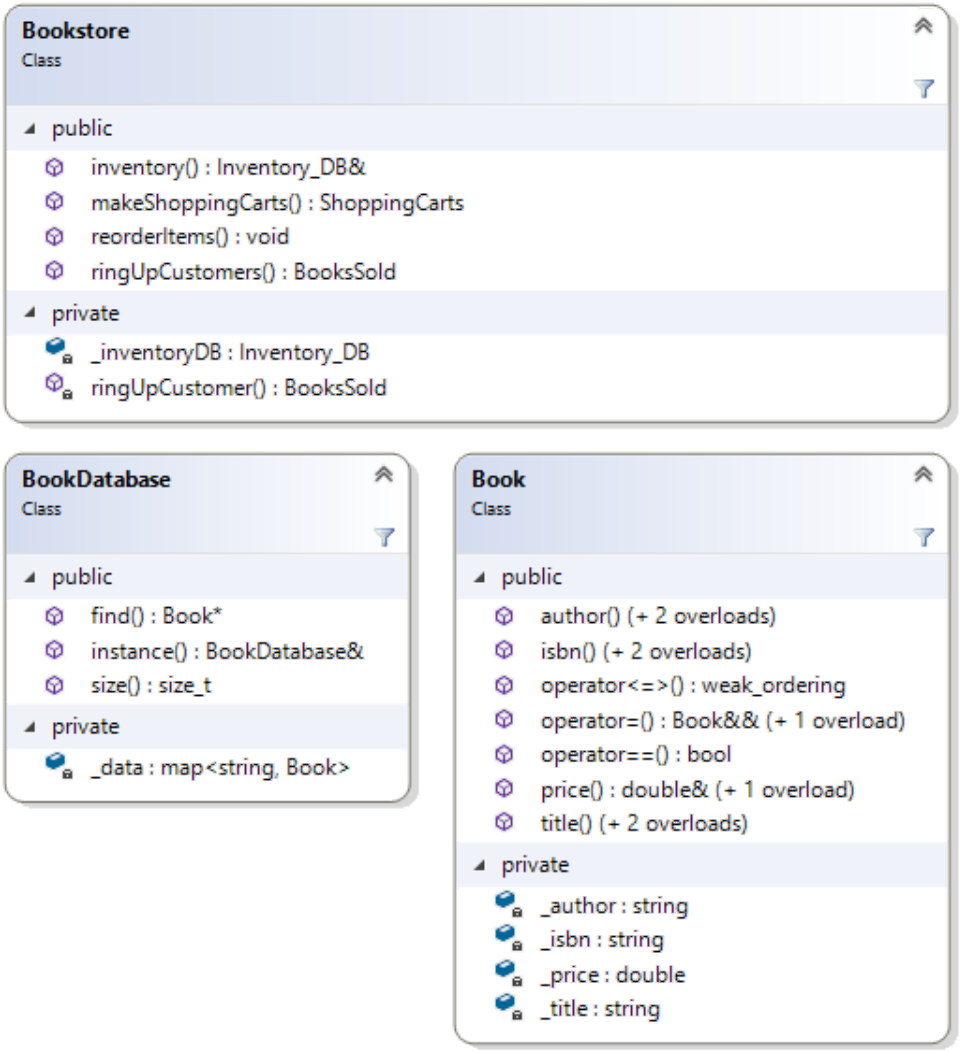
   ```
   Re-ordering books the store is running low on.

   1: {"9789999706124", "Professor Bear's Mathematical World (1st edition)", "James N. Boyd", 72.91}
      only 14 remain in stock which is 1 unit(s) below reorder threshold (15), re-ordering 20 more

   2: {"9802161748", "Wild mammals of Venezuela (1st edition)", "Rexford D. Lord", 47.74}
      *** no longer sold in this store and will not be re-ordered

   3: {"9789999746892", "Children and Television, Vol557 (1st edition)", "Amy B. Jordan", 59.60}
      only 13 remain in stock which is 2 unit(s) below reorder threshold (15), re-ordering 20 more
   ```

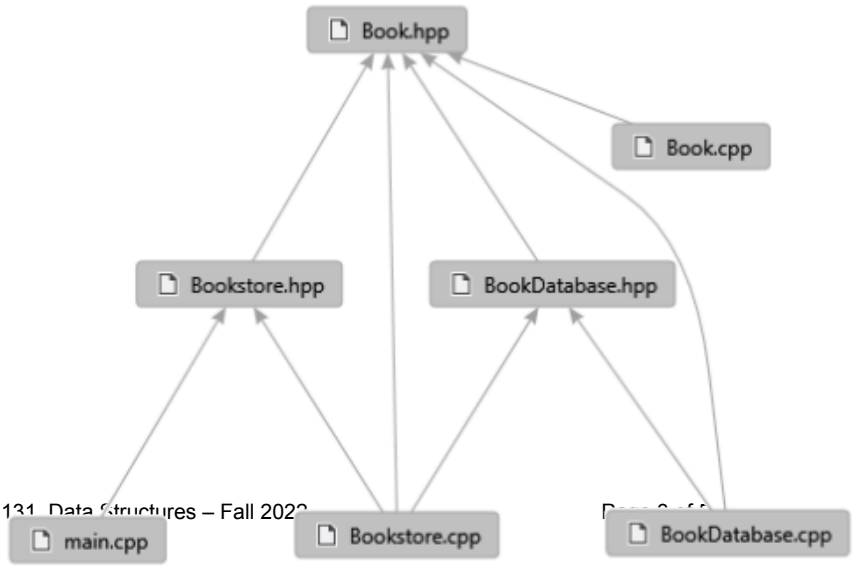
Program Overview:

Sometimes it helps to see pictures of what you're building. The following is just for information.

Class Structure: To help you visualize the interface your three classes provide, and to summarize instance attributes for the developer, the class diagram on the right is provided.

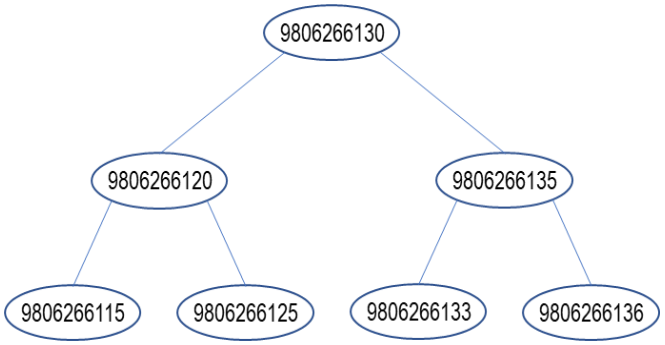
File Dependencies: To help you visualize the dependencies between included files, the diagram on the left is provided. Notice that each class has a header and source file pair, and that the class's source file always includes the class's header file. In this assignment, main.cpp requires only Bookstore's interface (header file). Bookstore's interface requires only Book's interface, but Bookstore's implementation (source file) requires Book's, BookDatabase's, and of course Bookstore's interfaces.



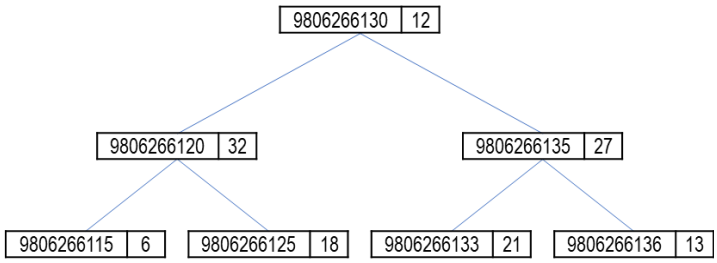


Data Types: To help you visualize the data structures, types and aliases, the following is provided:

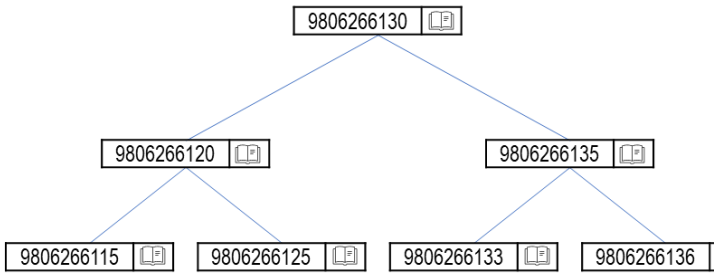
- BooksSold: a set of unique ISBNs organized as a binary search tree.



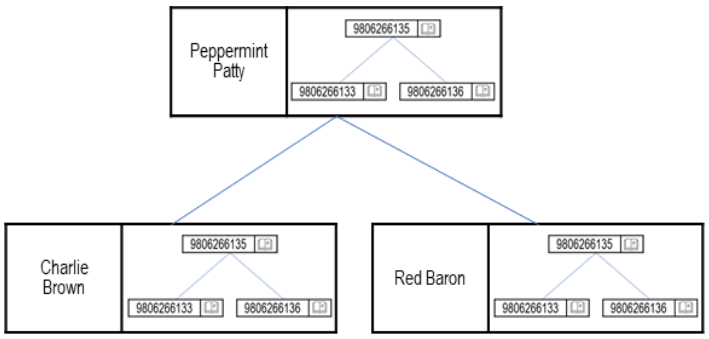
- Inventory_DB: an association from ISBN to quantity on hand organized as a binary search tree.



- ShoppingCart: a collection of books indexed by ISBN organized as a binary search tree.



- ShoppingCarts: a collection of shopping carts indexed by customer's name organized as a binary search tree. Analogous to a matrix being an array of arrays, ShoppingCarts is a tree of trees.



Rules and Constraints:

1. You are to modify only designated TO-DO sections. The grading process will detect and discard any changes made outside the designated TO-DO sections, including spacing and formatting. Designated TO-DO sections are identified with the following comments:

```
////////////////////////// TO-DO (X) ////////////////////////////////
...
////////////////////// END-TO-DO (X) ////////////////////////////////
```

   Keep and do not alter these comments. Insert your code between them. In this assignment, there are 13 such sections of code you are being asked to complete. 5 of them are in main.cpp, 3 in BookDatabase.cpp, and 5 in Bookstore.cpp.

Reminders:

- The C++ using directive `using namespace std;` is **never allowed** in any header or source file in any deliverable product. Being new to C++, you may have used this in the past. If you haven't done so already, it's now time to shed this crutch and fully decorate your identifiers.
- It is far better to deliver a marginally incomplete product that compiles error and warning free than to deliver a lot of work that does not compile. A delivery that does not compile clean may get filtered away before ever reaching the instructor for grading. It doesn't matter how pretty the vase was, if it's broken nobody will buy it.
- Use Build.sh on Tuffix to compile and link your program. The grading tools use it, so if you want to know if you compile error and warning free (a prerequisite to earn credit) than you too should use it.
- Filenames are case sensitive on Linux operating systems, like Tuffix.
- You may redirect standard input from a text file, and you must redirect standard output to a text file named output.txt. Failure to include output.txt in your delivery indicates you were not able to execute your program and will be scored accordingly. A screenshot of your terminal window is not acceptable. See How to build and run your programs. Also see How to use command redirection under Linux if you are unfamiliar with command line redirection.

Deliverable Artifacts:

Provided files	Files to deliver	Comments
Book.hpp BookDatabase.hpp Bookstore.hpp	1. Book.hpp 2. BookDatabase.hpp 3. Bookstore.hpp	You shall not modify these files that are provided to you in the initial commit of your github repository.
Book.cpp	4. Book.cpp	Replace with your (potentially updated) file from the previous assignment.
BookDatabase.cpp main.cpp Bookstore.cpp	5. BookDatabase.cpp 6. main.cpp 7. Bookstore.cpp	Start with the files provided. Make your changes in the designated TO-DO sections (only). The grading process will detect and discard all other changes. BookDatabase.cpp is similar to the previous assignment but needs updating to move from std::vector to std::map.
	8. readme	State your name and any grading remarks here
Open Library Database-Large.dat BookstoreInventory.dat		Text files with a book's full description and a bookstore's inventory databases. Do not modify these files.
BookDatabaseTests.cpp BookstoreTests.cpp BookTests.cpp CheckResults.hpp		These files are responsible for implementing the testing that is run through local_build.sh or github actions. If you have any tests that fail, looking at the tests around the location of the failure may be of help.