

# ECE 242: Data Structures and Algorithms- Fall 2015

## Project 5: a Book BST Library

Due Date: Deadline 11:50pm Wed December 2, 2015

### Description

For this project we propose to design and operate a book library. In contrast to project 1, we are going to use a more sophisticated data structure to store the library, a binary search tree (BST). Using a BST allows us to store an unlimited number of songs while being able to search them and display them in order.

Once the database that contains all the books is loaded to form a BST, we will be able to search a particular item, or extract a subtree that contains all the books that satisfy a more general user search request. From this particular subtree, one should be able to display the list of items, obtain the corresponding array and plot the tree structure. All the functionalities presented in the menu below should be successfully implemented to obtain full credit.

```
>java BookApp

Welcome to Book Collection App (10000 items)
=====

Menu
====
1-From admin BST database, extract user custom BST database using PubYear
2-From admin BST database, extract user custom BST database using Publisher
3-Display in-order user BST database
4-Convert user BST database into array of ISBN
5-Search admin database using ISBN array
6-Plot user BST database (via array)
0-Exit
```

### How to start

The project includes a database file `BookDB.txt` which includes a random list of 10,000 books. The books are listed one after another and each book contains five attributes: ISBN number, Title, Author, Publisher, Publication Year. The first few lines of the file are provide below:

```
10000
0671725955
PERFUME
Patrick Suskind
Pocket
1990
0767903285
Raise the Roof: The Inspiring Inside Story of the Tennessee Lady Vols' Undefeated 1997-98 Season
Pat Head Summitt
Broadway Books
1998
0671493515
FUND CONTRACT BRDG
```

```
Charles H. Goren
Pocket
1983
0434271918
The Liar
Stephen Fry
William Heinemann
1991
...
```

We note that:

- the very first line of the file contains the number of items. Since we are using a BST to store the database, it is not necessary to know the size a priori. However, for debugging purpose, you have here the possibility to work with smaller database by modifying the number of items in the first line.
- All the attributes (ISBN, Title, etc.) should be stored as **String** in your code. You will use the object **Book** to store them.

Each **Book** item represents a node of a BST. The BST has to be created by successive insertions of books in the database. This BST represents the administrator BST. Within the administrator BST, the books are sorted (in-order) by their ISBN number (do not forget ISBN are stored as **String** so you need to use the `compareTo` operator).

### Option 1: From admin BST database, extract user custom BST database using PubYear

If this option is selected, the user will be asked to enter a given year, the code will then create a subtree (user BST) that contains all the book items that have been published that year. **Important:** the books in the user BST database are sorted lexicographically (in-order) by their Title (not using their ISBN number!). Example:

```
Menu
====
1-From admin BST database, extract user custom BST database using PubYear
2-From admin BST database, extract user custom BST database using Publisher
3-Display in-order user BST database
4-Convert user BST database into array of ISBN
5-Search admin database using ISBN array
6-Plot user BST database (via array)
0-Exit
```

```
Command: 1
Which year are you interested in ?
1984
Begin subtree extraction for PubYear=1984 using in-order traversal
Number of items found= 102
```

```
Menu
====
1-From admin BST database, extract user custom BST database using PubYear
2-From admin BST database, extract user custom BST database using Publisher
3-Display in-order user BST database
4-Convert user BST database into array of ISBN
```

```

5-Search admin database using ISBN array
6-Plot user BST database (via array)
0-Exit

Command: 1
Which year are you interested in ?
1978
Begin subtree extraction for PubYear=1978 using in-order traversal
Number of items found= 38

```

Additional Requirements:

- Once the option 1 is selected, the code is asking Which year are you interested in ?
- Once the year is entered, the code is returning Begin subtree extraction for PubYear=1978 using in-order traversal where 1978 is here the particular year under consideration. As a Hint, you may want to use an in-order traversal of the administrator database to get the right item.
- Once the user BST is created the code is returning the number of items in the new user BST, here Number of items found= 38.
- Before the new menu is printed again, you will also allow a pause (press any keyboard to resume)..do this for all options..

## Option 2: From admin BST database, extract user custom BST database using Publisher

Same Option and Requirement as Option 1 but the Publisher name is used instead of the year. Example:

```

Menu
====
1-From admin BST database, extract user custom BST database using PubYear
2-From admin BST database, extract user custom BST database using Publisher
3-Display in-order user BST database
4-Convert user BST database into array of ISBN
5-Search admin database using ISBN array
6-Plot user BST database (via array)
0-Exit

Command: 2
Which publisher are you interested in ?
Hyperion
Begin subtree extraction for Publisher=Hyperion using in-order traversal
Number of items found= 37

```

## Option 3: Display in-order user BST database

This option is valid only if the user BST is defined. All the books in the user BST will be listed when the latter is traversed in order. It means that they will be sorted lexicographically by their title. Below is an example, that continues after the output of option 1 above (publication year is 1978 for all books). Note that when the option 3 is selected, the code returns information such as List in-order 38 items sorted by Title.

## Menu

====

- 1-From admin BST database, extract user custom BST database using PubYear
- 2-From admin BST database, extract user custom BST database using Publisher
- 3-Display in-order user BST database
- 4-Convert user BST database into array of ISBN
- 5-Search admin database using ISBN array
- 6-Plot user BST database (via array)
- 0-Exit

Command: 3

List in-order 38 items sorted by Title

0380400480 A Pirate's Love; Johanna Lindsey; Avon; 1978  
0846705672 American Way of Sex: An Informal Illustrated History (254p); Bradley Smith; Book Sales; 1978  
0440132118 As On A Darkling Plain; Bova Ben; Dell Publishing Co., Inc.; 1978  
0312087357 Bodysculpture: Weight Training for Women; Ralph L. Carnes; St Martins Pr; 1978  
0586045449 Bomber; Len Deighton; HarperCollins; 1978  
2264009306 Cantilnes en gele , Barnum's digest , Vingt pomes indits (10/18 [i.e. Dix/dix-huit] , 517); Boris Vian; 1978  
0140016821 Cider With Rosie; Laurie Lee; Penguin USA; 1978  
3499141639 Das L?cheln am Fu??e der Leiter.; Henry Miller; Rowohlt Tb.; 1978  
0380009560 Fantastic Imagination; Robert Boyer; Harper Mass Market Paperbacks (Mm); 1978  
0385134444 Farm Journal's Freezing and Canning Cookbook: Prized Recipes from the Farms of America; Nell Nichols; F  
0843105550 Gnome from Nome (Serendipity); Stephen Cosgrove; Price Stern Sloan; 1978  
0385128533 Goodbye California; Alistair MacLean; Bantam Dell Pub Group; 1978  
0394839129 I Can Read With My Eyes Shut (I Can Read It All by Myself Beginner Books); Dr. Seuss; Random House Chil  
0441354955 I, alien : a novel; Michael Reaves; Grosset & Dunlap; 1978  
0345310292 Illearth War / Thomas Covenant #02 (Chronicles of Thomas Covenant the Unbeliever); Stephen Donaldson; B  
0440940001 Island of the Blue Dolphins (Laurel Leaf Books); Scott O'Dell; Laure Leaf; 1978  
0140018328 Kiss Kiss (French Language Edition); Roald Dahl; French & European Pubns; 1978  
034531011X Lord Foul's Bane (The Chronicles of Thomas Covenant the Unbeliever, Book One); Stephen R. Donaldson; De  
0340223030 Lords of Misrule; Nigel Tranter; Hodder & Stoughton Ltd; 1978  
067170463X Murder on the Orient Express; Agatha Christie; Pocket Books; 1978  
0295955252 No-No Boy; John Okada; University of Washington Press; 1978  
0395264758 Picture Palace: A Novel; Paul Theroux; Houghton Mifflin Company; 1978  
0345301064 Ride Pegasus; Anne McCaffrey; Ballantine Books; 1978  
0671822845 STARCHILD TRILOGY; Frederik Pohl; Pocket; 1978  
0445044454 Sisters And Strangers; Helen Van Slyke; Fawcett Popular Books; 1978  
0345260627 Splinter of the Mind's Eye; Alan Dean Foster; Ballantine Books; 1978  
0140431357 Tess of the D'Urbervilles (Penguin Classics); Thomas Hardy; Penguin Books; 1978  
0060112719 The Azanian assignment; Iain Finlay; Harper & Row; 1978  
0345260317 The Dragons of Eden: Speculations on the Evolution of Human Intelligence; Carl Sagan; Ballantine Books;  
0380018179 The Thorn Birds; Colleen McCullough; Avon; 1978  
024189865X The bear's whelp: The autobiography of Robert Dudley, Duke of Northumberland, Earl of Warwick and Earl  
0500011931 The case of Walter Pater; Michael Levey; Thames and Hudson; 1978  
0156907380 To the Lighthouse; Virginia Woolf; Harvest Books; 1978  
8429713948 Trajecte final (Collecci universal de butxaca El Cangur , 39); Manuel de Pedrolo; Edicions 62; 1978  
0451523318 Turn of the Screw and Short N; Henry James; Signet Book; 1978  
0877790388 Webster's Legal Speller; Springfield; Merriam Webster; 1978  
015696158X When God Was a Woman (Harvest/Hbj Book); Merlin Stone; Harvest Books; 1978  
0525237704 World According to Garp: A Novel; John Irving; Penguin USA; 1978

## Option 4: Convert user BST database into array of ISBN

This option is valid only if the user BST is defined. The goal is to obtain an array representation of the user BST. We will consider an array of `String` with a maximum size of 1023. It means that the array can only store up to 9 levels (the root node is at level 0). The array contains only the ISBN number of the

books. Empty cells in the array should take the value “N/A”. Once the array is created, all the filled cells containing the ISBN numbers are displayed. In addition, the code returns the number of items that have been included in the array, as well as the height of the tree (number of levels). Example for the example consider in Option 3:

```
Menu
====
1-From admin BST database, extract user custom BST database using PubYear
2-From admin BST database, extract user custom BST database using Publisher
3-Display in-order user BST database
4-Convert user BST database into array of ISBN
5-Search admin database using ISBN array
6-Plot user BST database (via array)
0-Exit

Command: 4
[i]      ISBN
0   0060112719
1   0140016821
2   0156907380
3   0312087357
4   0140018328
5   024189865X
6   015696158X
7   0380400480
8   0586045449
9   0345310292
10  0140431357
11  0345260317
12  0500011931
13  0451523318
14  0525237704
16  0440132118
18  2264009306
19  0380009560
20  0440940001
21  0295955252
24  0380018179
27  8429713948
28  0877790388
33  0846705672
39  3499141639
40  0385128533
43  0340223030
44  0345260627
81  0385134444
82  0394839129
87  034531011X
88  067170463X
89  0345301064
164 0843105550
166 0441354955
179 0395264758
180 0445044454
361 0671822845

Number of items 38; Number of levels 8
```

## Option 5: Search admin database using ISBN array

This option is valid only if the user BST is defined, its size is greater than 0 and if the array is also defined. All the non "N/A" ISBN numbers in the array are searched for in the administrator BST database, that will return of the information of the corresponding book. The find method should be optimal using the  $O(\log N)$  binary search technique. Here an example of the output for the case consider in Option 4.

Menu

====

1-From admin BST database, extract user custom BST database using PubYear  
2-From admin BST database, extract user custom BST database using Publisher  
3-Display in-order user BST database  
4-Convert user BST database into array of ISBN  
5-Search admin database using ISBN array  
6-Plot user BST database (via array)  
0-Exit

Command: 5

0060112719 The Azanian assignment; Iain Finlay; Harper & Row; 1978  
0140016821 Cider With Rosie; Laurie Lee; Penguin USA; 1978  
0156907380 To the Lighthouse; Virginia Woolf; Harvest Books; 1978  
0312087357 Bodysculpture: Weight Training for Women; Ralph L. Carnes; St Martins Pr; 1978  
0140018328 Kiss Kiss (French Language Edition); Roald Dahl; French & European Pubns; 1978  
024189865X The bear's whelp: The autobiography of Robert Dudley, Duke of Northumberland, Earl of Warwick and Earl  
015696158X When God Was a Woman (Harvest/Hbj Book); Merlin Stone; Harvest Books; 1978  
0380400480 A Pirate's Love; Johanna Lindsey; Avon; 1978  
0586045449 Bomber; Len Deighton; HarperCollins; 1978  
0345310292 Illearth War / Thomas Covenant #02 (Chronicles of Thomas Covenant the Unbeliever); Stephen Donaldson; B  
0140431357 Tess of the D'Urbervilles (Penguin Classics); Thomas Hardy; Penguin Books; 1978  
0345260317 The Dragons of Eden: Speculations on the Evolution of Human Intelligence; Carl Sagan; Ballantine Books;  
0500011931 The case of Walter Pater; Michael Levey; Thames and Hudson; 1978  
0451523318 Turn of the Screw and Short N; Henry James; Signet Book; 1978  
0525237704 World According to Garp: A Novel; John Irving; Penguin USA; 1978  
0440132118 As On A Darkling Plain; Bova Ben; Dell Publishing Co., Inc.; 1978  
2264009306 Cantilnes en gele , Barnum's digest , Vingt pomes indits (10/18 [i.e. Dix/dix-huit] , 517); Boris Vian;  
0380009560 Fantastic Imagination; Robert Boyer; Harper Mass Market Paperbacks (Mm); 1978  
0440940001 Island of the Blue Dolphins (Laurel Leaf Books); Scott O'Dell; Laure Leaf; 1978  
0295955252 No-No Boy; John Okada; University of Washington Press; 1978  
0380018179 The Thorn Birds; Colleen McCullough; Avon; 1978  
8429713948 Trajecte final (Collecci universal de butxaca El Cangur , 39); Manuel de Pedrolo; Edicions 62; 1978  
0877790388 Webster's Legal Speller; Springfield; Merriam Webster; 1978  
0846705672 American Way of Sex: An Informal Illustrated History (254p); Bradley Smith; Book Sales; 1978  
3499141639 Das L?cheln am Fu??e der Leiter.; Henry Miller; Rowohlt Tb.; 1978  
0385128533 Goodbye California; Alistair MacLean; Bantam Dell Pub Group; 1978  
0340223030 Lords of Misrule; Nigel Tranter; Hodder & Stoughton Ltd; 1978  
0345260627 Splinter of the Mind's Eye; Alan Dean Foster; Ballantine Books; 1978  
0385134444 Farm Journal's Freezing and Canning Cookbook: Prized Recipes from the Farms of America; Nell Nichols; B  
0394839129 I Can Read With My Eyes Shut (I Can Read It All by Myself Beginner Books); Dr. Seuss; Random House Chil  
034531011X Lord Foul's Bane (The Chronicles of Thomas Covenant the Unbeliever, Book One); Stephen R. Donaldson; De  
067170463X Murder on the Orient Express; Agatha Christie; Pocket Books; 1978  
0345301064 Ride Pegasus; Anne McCaffrey; Ballantine Books; 1978  
0843105550 Gnome from Nome (Serendipity); Stephen Cosgrove; Price Stern Sloan; 1978  
0441354955 I, alien : a novel; Michael Reaves; Grosset & Dunlap; 1978  
0395264758 Picture Palace: A Novel; Paul Theroux; Houghton Mifflin Company; 1978  
0445044454 Sisters And Strangers; Helen Van Slyke; Fawcett Popular Books; 1978  
0671822845 STARCHILD TRILOGY; Frederik Pohl; Pocket; 1978  
Search Time 3ms

We note that:

- the book appears in order of their ISBN number (search order).
- The code returns the total search time in milliseconds (to find all the books considered).

### Option 6: Plot user BST database (via array)

This option is valid only if the user BST is defined, its size is greater than 0 and if the array is also defined. We propose here to plot graphically the user BST structure. The array representation can be used to know which cells are occupied and it can help defining coordinates x and y for each cell to be plotted.

We will be using the library developed by R. Sedgewick `StdDraw.java` which is included in this project. Description of methods can be found in <http://introcs.cs.princeton.edu/java/stdlib/javadoc/StdDraw.html>. Various documentations, examples and tutorials are also available in the internet. For this project, you may need to use only few methods:

- `StdDraw.setCanvasSize(...)` to set the window size (default is 512x512)
- `StdDraw.setXscale(...)` to set the x scale (default is [0,1])
- `StdDraw.setYscale(...)` to set the y scale (default is [0,1])
- `StdDraw.setPenColor(...)` to set the color of the pen (default is `StdDraw.BLACK`)
- `StdDraw.filledCircle(x,y,r)` to plot a filled circle at coordinate x,y with radius r
- `StdDraw.line(x1,y1,x2,y2)` to plot a line between two points 1 and 2

You should write the method such that the BST appears as clearly as possible. Example for the 1978 year is provided in Figure 1.

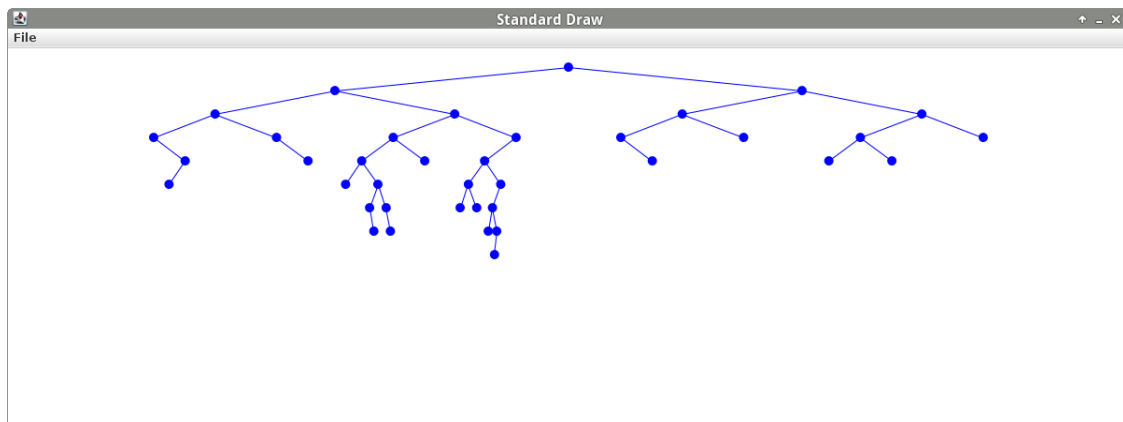


Figure 1: BST representation of the books that belong to year 1978 (ordered by Titles).

## REQUIREMENT, SUBMISSIONS

1. Attention a skeleton of the code is not provided this time. You need to carefully review all the requirements and specifications of this project. However, you will use only 3 classes: `Book`, `BookBST`, `BookApp`. The latter contains 2 static methods, the `ToolsMenu` that prints the menu and the `main` method.
2. You will work alone or in groups of two maximum. **Each group should submit one copy of the solution. Please do not forget to include the name of both partners!** Include the **name**, **student ID**, and **email address** of both partners. This information should be included in a README file. Submit a single zip file composed of: All your source files (\*.java), your README file.

## **Grading Policy**

This project will be graded out of 100 points:

1. Your program should compile successfully. (10 points)
2. Your program should implement all functionalities and run correctly. (70 points)
3. Overall programming style: source code should have proper identification, and comments. (20 points)

## **Extra Credit**

No extra credit for this project. However you can earn extra 10 points (5+5 points) by reporting the results of your Homework to the TA (HW5 and upcoming HW6).