A template with a preliminary implementation is provided in BeachBoard (template.zip) under *Template* of the *Content Tab*. The template provides the classes and a simple menu to interact. Modify the menu to support the required functionalities. Read the readme.txt file for the documentation.
Note Only assignments that use the template will be graded.

LAB 5: HEAPS

Learning objectives: CLO 1, CLO 3, CLO 4
Use Python 3.8 or higher for the assignment:

1. Implement the BinaryHeap including the operations $add(x)$, and $remove(x)$ covered in class.

   Learning objectives: CLO 1, CLO 3

   Test your program:

   - Remove one element from an empty BinaryHeap
   - Add 3 elements: $add(2)$, $add(1)$, $add(5)$
   - Check that $size()$ returns 3
   - Remove one element: $remove()$ and check that it returns 1.
   - Add 3 elements: $add(4)$, $add(1)$, $add(3)$.
   - Check that $size()$ returns 5
   - Remove all the elements and check that they return in order 1,2,3,4,5

2. Book Store System. In development time, use the file "booktest.txt" with few books. Once you think it is ready, use the main file "books.txt".

   Learning objectives: CLO 1, CLO 3, CLO 4

   (a) Using Lab 1 or lab 2, load the catalog "books.txt" in an instance $bookCatalog$ of your list implementation (either DLList or ArrayList). Each row in books.txt is a book that we store in a node. Thus, $bookCatalog$ stores a list of the class Books.

   (b) Search books by infix and present the k best seller books: Given a prefix $prefix$, find all the books in $bookCatalog$ that contain $prefix$ and add them to $bestSellers$ which is an instance of the BinaryHeap. Then remove the first k books and display the index and the title for each. For example, you can use $k = 20$.
   Hint: Multiply all the ranks by -1 so the maximum becomes the minimum.

   Test your program:

   - Searching for books by:
     (a) Empty prefix.
     (b) "World": The 10 best sellers books should be:

```
3610862: The World Impact of Nafta
3601953: International Justice and the Third World
3598929: El Mundo Del Microscopio (Coleccion Libros Visuales/the World of the Microscope)
3491585: The 2000 World Forecasts of Wine Export Supplies (World Trade Report)
3489234: The 2000 Import and Export Market for Wine in India (World Trade Report)
3485613: The 2000 Import and Export Market for Wine in Asia (World Trade Report)
3485611: The 2000 Import and Export Market for Alcoholic Beverages in India (World Trade Report)
3477287: Croatia Investment & Business Guide (World Investment and Business Library)
3476936: South Slavic Writers Since World War II (Dictionary of Literary Biography)
3476176: The 2000 Import and Export Market for Manufactured, Smoking, and Chewing Tobacco in Bangladesh (World Trade Report)
```

3. What is the advantage and disadvantage of BinaryHeap over BinarySearchTree data structures.

   Learning objectives: CLO 4

Submit all the source code (Python files (.py) in a zip file. The name of the zip file with the source code must be your first name, second name, and the data structure separated by a hyphen. For example, oscar-ponce-heaps.

Submissions that do not follow the previous specification will be rejected and you will have 0 in the lab.

RUBRICS

	Level 4 2 Pt	Level 3 1.5 Pt	Level 2 1 Pt	Level 1 0.5 Pt
BinaryHeap implementation	It is always correct without crashes	Eventually it crashes or return incorrect results	It frequently crashes and/or return incorrect results	It is not correct or incomplete
Searching best-seller books by infix	It is always correct without crashes	Eventually it crashes or return incorrect results	It frequently crashes and/or return incorrect results	It is not correct or incomplete
Answer to Question 3	N/A	N/A	Correct	Incorrect