Homework 3

CS201 - Data structures & Algorithms

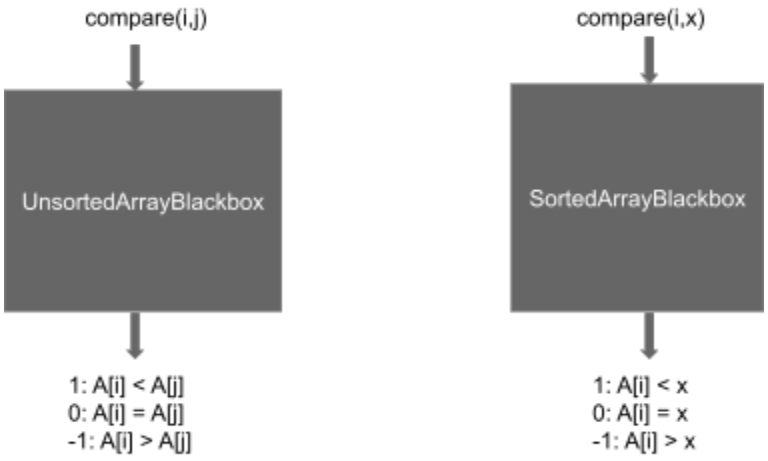
Spring 2024

This homework is to help you practice basic algorithms of sorting and searching. We will **not grade your coding style** but you should **make your code as readable as possible**.

Question (Finding the median of an unsorted array and searching an element from a sorted array): You are required to implement efficient algorithms to find the median of an unsorted array and search for an element of a sorted array. Your algorithm, however, will not be able to access these arrays directly. Instead, it will query the information about comparing elements of these arrays from a third-party object. By that, we can count how many comparisons your algorithm needs, and thus we can measure the efficiency of your algorithm.

Specification: Third-party objects are from the UnsortedArrayBlackbox/SortedArrayBlackbox classes where

1. An object of the **UnsortedArrayBlackbox** class has an internal unsorted array **A** of integers that your algorithm can not access directly. Your algorithm can only access this array through the method **"int compare(int i, int j)"** that will return 1, 0, or - 1 if A[i] < A[j], A[i] = A[j], or A[i] > A[j] respectively (see the figure below).
2. An object of the **SortedArrayBlackbox** class has an internal ascendingly sorted array **A** of integers. Your algorithm can only access this array through the method **"int compare (int i, int x)"** that will return 1, 0, or - 1 if A[i] < x, A[i] = x, or A[i] > x respectively (see the figure below).
3. Both UnsortedArrayBlackbox and SortedArrayBlackbox have
    a. a method **get_length()** so that you can get the length of the internal array.
    b. a method **get_comparison_num()** so that you can measure how many comparisons you have queried.



Your task is to implement a class named **"Sorting_and_searching_hw3"** that has **no relationship with UnsortedArrayBlackbox/SortedArrayBlackbox classes** to find the median of an unsorted array and search for an element from an sorted array. This class has

1. A constructor that has no parameters.
2. A public method **"int get_median_index(UnsortedArrayBlackbox unsorted_arr_bb)"** that returns the index of the median of the internal array of unsorted_arr_bb. We assume that the internal array only contains an odd number of distinct integers for simplicity.
3. A public method **"int get_index(SortedArrayBlackbox sorted_arr_bb, int x)** that returns the index of x in the internal array of sorted_arr_bb if this internal array contains x, otherwise return -1.

Sample test cases: All test cases are attached in the template code file.

Implementation & submission: Use the template code file (attached on Canvas) and

1. Add your code to implement the "get_median_index" and "get_index" methods.
2. The code of UnsortedArrayBlackbox/SortedArrayBlackbox classes is provided on Canvas. On your local computer, you are free to organize the package and import the code of these classes to test your implementation. However, to submit and test your "Sorting_and_searching_hw3" file with the Homework 3 on the GradeScope, you have to organize the package and import the classes as

```
package com.gradescope.cs201;
import com.gradescope.cs201.UnsortedArrayBlackbox;
import com.gradescope.cs201.SortedArrayBlackbox;
```