Northeastern University
CS5800 Algorithms, Fall 2024

Instructor: Hyonho Lee

Assignment 3
(Total Marks: 50 pts)

Due Date: October 7, 2024, 6pm

Name: _____

Student Number: _____

Collaborators: _____

I, _____, read and understood Northeastern University's Academic Integrity Policy (https://osccr.sites.northeastern.edu/academic-integrity-policy/).

1. (20 pts) Write a Python function, `median(X, Y)`, which returns the median of all elements of lists `X` and `Y`, where the sizes of `X` and `Y` are the same and each are sorted. (CLRS Exercise 9.3-10)

Your algorithm should run in $O(\log n)$ time, where n is the length of each list. So, you should NOT do linear search or run a sorting algorithm. Assume that each list contains at least one number, and all numbers are **distinct**.

```
def median(X, Y):
    ### Write Your Code Here ###

median([1], [2]) # return 1.5
median([1, 2], [3, 4]) # returns 2.5
median([2, 3], [1, 4]) # returns 2.5
median([1,3,5,7], [2,4,6,8]) # returns 4.5
median([1,2,3,4], [5,6,7,8]) # returns 4.5
median([1,3,5,7,9], [2,4,6,8,10]) # returns 5.5
median([1,3,7,8,9], [2,4,5,6,10]) # returns 5.5
median([10,20,30,100], [15,40,60,90]) # returns 35.0
```

2. (30 pts) Write a Python function, `median2(X, Y)`, which returns the median of all elements of lists `X` and `Y`, where the sizes of `X` and `Y` **may be different** and each are sorted.

Your algorithm should run in $O(\log(m+n))$ time, where m is the length of `X` and n is the length of `Y`. Assume that each list contains at least one number, but there **may be duplicated numbers**.

```python
def median2(X, Y):
    ### Write Your Code Here ###

median2([1], [2, 3]) # return 2.0
median2([1, 3], [2]) # return 2.0
median2([1, 2], [3, 4]) # returns 2.5
median2([1,2,3,4], [3,4]) # returns 3.0
median2([0,0,0,2,2], [1,1,1,1,1]) # returns 4.5
median2([1,3,5,7,9], [2,4,6,8,10,11]) # returns 6.0
median2([1,3,7,8,9], [2,4,5,6,10,11]) # returns 6.0
median2([1], [2,3,4,5,6,7]) # returns 4.0
median2([10,20,30,100], [40,60]) # returns 35.0
```

Practice Exercises

(The following questions will not be graded. Do not submit solutions. But similar questions may appear in the exams.)

CLRS Exercise 7.1-1

CLRS Exercise 7.2-1, 7.2-2, 7.2-3

CLRS Exercise 7.4-1, 7.4-3

CLRS Exercise 8.1-3, 8.1-4

CLRS Exercise 8.2-1, 8.2-6 (8.2-4 for 3rd ed.)

CLRS Exercise 8.3-1, 8.3-3, 8.3-5 (8.3-4 for 3rd ed.)

CLRS Exercise 8.4-3

CLRS Problem 8-1

CLRS Exercise 9.1-1

CLRS Exercise 9.3-6 (9.3-5 for 3rd ed.), 9.3-7, 9.3-9

CLRS Problem 9-1