# Programming Assignment 2 Due: 4/17/2023

The objective of this assignment is to explore an interesting algorithm known as kth smallest element in an array.

# Problem Definition:

The kth order statistics of an array a of n elements is the kth least element in the array, 𝑘𝑘 = 0, … , 𝑛𝑛 − 1. Moreover, finding the kth order statistics of a can be accomplished by the following solutions

1. Sorting a and returning the kth element in the sorted array. Using any sorting in 𝑂𝑂(𝑛𝑛 𝑙𝑙𝑙𝑙𝑙𝑙𝑛𝑛 )

would do the task!

1. Using Quicksort and reduce the running time for finding the kth statistics down to 𝑂𝑂(𝑛𝑛).

# Assignment

1. Implement two algorithms:
   1. A min heap, that finds the kth smallest element of a given input array and the value k.
   2. Use quicksort (with some modification) to find the kth smallest element of a given input array and the value k.
2. For both algorithms inputs and outputs are similar. Here are some examples:
   1. Example1:

Input: [8, 4, 1, 2, 10] and k = 3

Output: 4

* 1. Example2:

Input: [7, 10, 4, 3, 20, 15] and k = 4

Output: 10

1. The algorithm for MinHeap can be found from class lecture notes.
2. The following pseudocode can be used for 1-a algorithm. This algorithm uses Quicksort concept to find the kth element in an arbitrary array.

**function** kthSmallest(arr, l, r, k)

**{**

**if** (k > 0 and k <= r – l)

q = partition(arr, l, r) // make a partition using the last element

**if** (q == k ) // if position is same as k return arr[pos]

**if** (q > k ) //if position is more, # recur for left subarray

**return** kthSmallest(arr, l, q - 1, k)

**return** kthSmallest(arr, q + 1, r, k - q + l)

}

**Note:** You may need to correct the array boundaries for python (e.g. starting from zero) 5- Your program should work for any array, as usual.

# What to submit?

1. Write 2 programs for each algorithm. Please name your programs as follows:
   1. minheapfind\_yourname.py
   2. quickfind\_yourname.py
2. Your programs should be run as follows:

* minheapfind\_youname.py [10,2,3,5] 2 or quickfind\_yourname.py [10,2,3,5] 2 The first input is an array and the second input in the value of k
* Both programs return an integer indicating the value of kth smallest element in the list.

Note: make sure test your program for boundary inputs!

1. Please have your name top of your all programs.
2. You should follow general software development rules such as proper and sufficient commenting if it is necessary and proper functions and variables naming.
3. Do not copy any code from online resources!