Beihang University
School of General Engineering

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Computer Science and Programming
Lab Class 10

Task 1 k-selection - random *(20 minutes)*

Implement a function to select the k-th smallest element in an unsorted list using the random selection strategy introduced in the lecture. If you forget about the concept, go back to the slides (Page 12, 13 in slides of Lecture 9) for a short review. Please follow these steps:

1. Implement a function (several lines of code) that randomly selects an element in a list. The function should have one list as its input and the selected element's value as its output.

2. Implement a function for partitioning. Following the code in [1], your function should compare all the elements in a list with the selected element (p) and put the elements larger than p and smaller than p in two separate lists.

3. Based on the solutions for [1] and [2], implement a recursive function *kselect random*. Please think about the cases for (left/right/pivot) and how to adapt the value of k without looking at the slides.

4. Now you have implemented the random method for k-selection. With the analysis from the lecture, the time complexity of this method is in $O(n^2)$. Is this method faster or the naive method faster? Explain your answer and idea.

Task 2 k-selection - median of median *(30 time)*

Implement a function `kselect_medianOfMedian`, which follows the idea presented in the last lecture, allowing to find the k-th smallest element in $\Theta(n)$.

Task 3 *k-selectiom-application* *(10 minutes)*

You are consulting for an oil company, which is planning a large pipeline running east to west through an oil field of n wells. The company wants to connect a spur pipeline from each well directly to the main pipeline along a shortest route (either north or south), as shown in figure. Given the x- and y-coordinates of the wells, how should you pick the optimal location of the main pipeline (y coordinate), which would be the one that minimizes the total length of the spurs? Show how to determine the optimal location in linear time, and write a python programme to implement it.

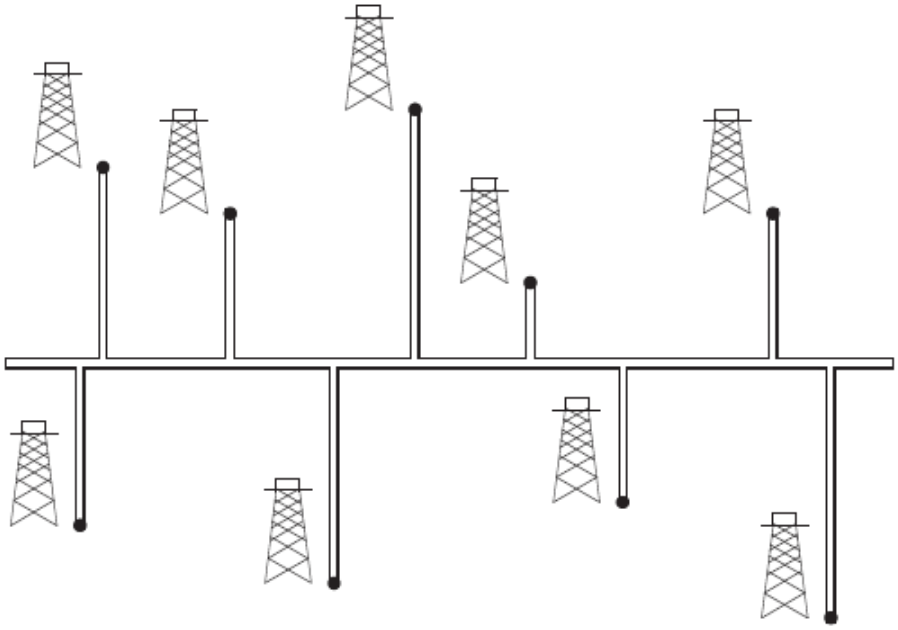

Figure 5: Task 3

Task 4 ***median of two sorted list****(20 minutes)*

Let X and Y be two lists, each containing n numbers already in sorted order. Write a python program to find the median of all 2n elements in lists X and Y. Noted that the time complexity of your program should be $O(lgn)$.