

Problem Solving Workshop #10
July 16, 2016

Tech Interviews and Competitive Programming Meetup

<https://www.meetup.com/tech-interviews-and-competitive-programming/>

Instructor: Eugene Yarovoi (can be [contacted](#) through the group Meetup page above under Organizers)

More practice questions: leetcode.com, glassdoor.com, geeksforgeeks.org

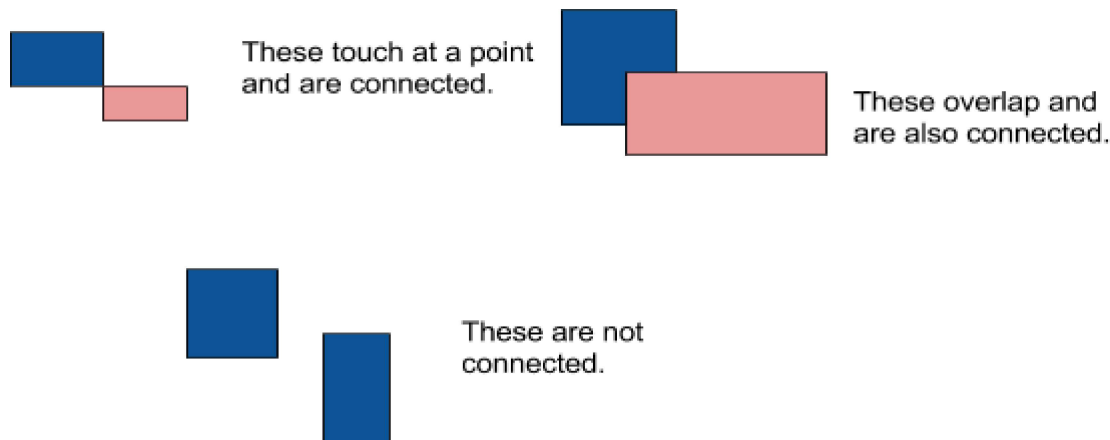
Books: Elements of Programming Interviews, Cracking the Coding Interview

Have questions you want answered? Contact the instructor, or ask on [Quora](#). You can post questions and [follow the instructor](#) and other people who write about algorithms.

Try to find optimized solutions, and provide a time and space complexity analysis with every solution.

Coding / Algorithm Problem #1

You are given N axis-aligned rectangles. An axis-aligned rectangle is one whose axes are parallel to the x - and y -axes (the rectangles are not rotated). Your goal is to determine whether all these rectangles form a single, connected shape. Two rectangles are considered to be connected if they touch at any point, but they can also overlap. For example:



Of course, there may be more than 2 rectangles. The goal is to determine whether the entire shape made by all the rectangles is connected (formally, the shape is connected if every rectangle is connected to every other rectangle directly, or transitively through another rectangle).

A rectangle is given as a 4-tuple (leftX, rightX, topY, bottomY). You're given an array of N rectangles.

- (i) **(Easy)** Give an algorithm that determines whether just 2 rectangles are connected.
- (i) **(Easy-Medium)** Give an algorithm for the N -rectangle problem that runs in $O(N^2)$ or better. Your time complexity should not strongly depend on the sizes of the rectangles or the sizes of the coordinates.
- (ii) **(Medium)** Suppose that all the coordinates of the rectangles are integers and that the rectangles also have relatively small areas. Solve in $O(N * \text{average area of a rectangle})$.

(iv) **(Very Hard)** Solve in $O(N \log N)$ without making assumptions about the sizes of the rectangles or the X and Y coordinates, just like in part (i).

Algorithm Problem #2

You have N processes in a mobile operating system. Each process can run in high or low power mode. Processes running in high power mode are able to provide more utility to the user, such as pushing notifications or proactively searching online for autocomplete suggestions. We'd like to run as many processes as possible in high power mode, but to make sure the user's battery doesn't drain too fast, we have a budget for how much total battery power the device should use.

The N processes are described by an array of size N of 4-tuples (low power usage, low power user utility, high power usage, high power user utility). We measure power usage in units of hundredths of a percent per hour, so a power usage of 200 would be 2% of the overall battery per hour. User utility is some rating where higher numbers are better. Both user utility and power usage are integers. You are also given an integer P representing the maximum allowable power usage.

The goal is to output which processes should be run in which mode so as to maximize the total (sum) user utility while using P power or less.

- () **(Easy)** Give any solution to this problem. It can be inefficient.
 - (i) **(Medium-Hard)** Give a more efficient solution.
 - (ii) **(Hard)** Now suppose that the choice isn't just between low power and high power, but that each process may have a list of (power use, utility) 2-tuples that represent possible power settings. How would you solve the problem now?
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SYSTEM DESIGN PROBLEM

How would you design a maps application such as Google Maps, Apple Maps, Bing Maps, Mapquest, etc.? There could be a lot of features within such an app, but focus on the following:

- How would you adjust the map shown to the user as they zoom in and out, or scroll the view?
- How would you design the feature that overlays the map with icons for businesses and points of interest?
- How would you implement the feature that provides directions from point A to point B?

Generally speaking, in design questions, there's always lots of ambiguity, so you would start by asking clarifying questions to the interviewer. Since you don't have an interviewer here, assume what you think are reasonable answers to the questions you would ask.