HOMEWORK 2
Due Thursday, July 2, 2015 @ 2:10pm

IMPORTANT: The stated deadline on assignments will be strictly enforced. I will go over solutions at the deadline and will not accept submissions after the solutions have been presented.

Homework can be submitted at any time before the deadline as either a hard copy or electronically. If submitting electronically, use a recognizable filename (ex. "homework1.pdf") and submit with `submit_cse331` or as an email attachment sent to me.

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1. (40 points) Exercise 3 in Chapter 4:

   You are consulting for a trucking company that does a large amount of business shipping packages between New York and Boston. The volume is high enough that they have to send a number of trucks each day between the two locations. Trucks have a fixed limit W on the maximum amount of weight they are allowed to carry. Boxes arrive at the New York station one by one, and each package i has weight w_i. The trucking station is quite small, so at most one truck can be at the station at any time. Company policy requires that boxes are shipped in the order they arrive; otherwise, a customer might get upset upon seeing a box that arrived after his make it to Boston faster. At the moment, the company is using a simple greedy algorithm for packing: they pack boxes in the order they arrive, and whenever the next box does not fit, they send the truck on its way.

   They wonder if they might be using too many trucks, and they want your opinion on whether the situation can be improved. Here is how they are thinking. Maybe one could decrease the number of truck needed by sometimes sending off a truck that was less than full, and in this way allow the next few trucks to be better packed.

   Prove that, for a given set of boxes with specified weights, the greedy algorithm currently in use actually minimizes the number of trucks that are needed. Your proof should follow the type of analysis we used for the Interval Scheduling Problem: it should establish the optimality of this greedy packing algorithm by identifying a measure under which it "stays ahead" of all other solutions.

   Proof: 40 pts

2. (45 points) Exercise 5 in Chapter 4:

   Let's consider a long, quiet country road with houses scattered very sparsely along it. We can picture the road as a long line segment, with an eastern endpoint and a western endpoint. Further, let's suppose that despite the bucolic setting, the residents of all these houses are avid cell phone users. You want to place cell phone base stations at certain points along the road, so that every house is within four miles of one of the base stations.

   Give an efficient algorithm that achieves this goal using as few base stations as possible. Note that it doesn't matter how far a house is from a base station as long as it's within four miles (i.e. four miles away is just as good as being one mile away, but 4.001 miles away is unacceptable.).

Correct algorithm: 15 pts

Proof of correctness: 20 pts

Runtime analysis: 10 pts

3. (15 points) **Interview Question**

Binary search is a common search algorithm that is used extensively in computer science which allows us to find a value in a sorted array in $\Theta(\log n)$ time. However, if we no longer use an array to store the data, this algorithm may be useless.

For this question, you are required to write an algorithm to find a value in an $n \times n$ matrix (2D-array). You are guaranteed that each row and column of the matrix is sorted. Write an $O(n)$ time algorithm to find a given value in this matrix.

Correct algorithm: 15 pts (no formal proof required, but the algorithm has to be right and run in $O(n)$ time.)