Due: Friday, 11 April 2014

Collaboration: You must work on problem one individually. If you collaborated with someone during lab to create a spreadsheet and/or graph for problem 2, please acknowledge that person’s contribution. Each of you should submit your own printout and individual, separate writeups for 2(b) an 2(d).

Submission: Turn in a printed copy of your work at the beginning of class.

1. You have a knapsack that can only hold 25 pounds. However, you have a lot of classes and a dorm room that very far from the academic buildings, so you’d like to take as many books as possible with you. Of course, books are heavy, so there is no way you can take them all in your skimpy knapsack. Let us say you have 19 books that you’d like to carry, each of them weighing between one and three pounds.

(a) If you had a very very weak knapsack that could only carry two books. How many possible pairs of books could you carry?

(b) If you could fit three books in your bag, how many possible triplets of books could you carry?

(c) If you resorted to any number of your 19 books (from zero to 19) in your book bag, how many possible combinations of books would there be?

(d) Of these many combinations, you want to find the one that allows you to carry the most, without exceeding your knapsack’s weight capacity. Assuming there’s not a computer science major in your dorm to write an algorithm to help you, it will take you five seconds to manually check the weight of one particular combination of books. Considering your answer to (c), how long will it take you to find the largest number of books you can carry?

Please express your answer in a unit whose scale is comprehensible and commensurate with the value it is associated with (for example, 437,289 inches is not intuitively meaningful. 437,289 inches · \(\frac{1}{12}\) inches = 36,440.75 feet is better, but not great. 437,289 inches · \(\frac{1}{12}\) inches · \(\frac{1}{5280}\) feet ≈ 6.9 miles is most reasonable).

(e) Of course, you are usually in a hurry when you leave your dorm room, so you are willing to sacrifice some accuracy to get a faster algorithm. Suggest an algorithm that would allow you to quickly place several books in your knapsack—not necessarily the greatest number possible—without exceeding its capacity. What is the greatest number of steps your algorithm could take?¹

Note: If you do not have a scientific calculator that will allow you to expand your expressions into numbers, one is available on the MathLAN computers by typing the command xcalc in a Terminal window.

2. On Wednesday April 2, you conducted a lab, performing experiments on sorting algorithms.

(a) Include your graphs of the number of comparisons made under the various initial conditions of the data for insertion and quick sort. You should have at least three graphs (one for ascending, descending, and randomly ordered data). If you chose to put both quicksort and insertion sort on the same axes, you will have only three. If you chose to put the two sorting algorithms on different axes, you will have six graphs. Please remember to clearly label your axes and title your graphs and curves.

Note: To more easily distinguish the trends, I recommend you plot the different sorts on two separate axes.

(a) Include your answers to the four questions (a)-(d) from Part II, Exercise 4: Analyzing Data.

(b) Include your graphs of the numbers of comparisons made under the various initial conditions of the data for the bogo-sort algorithm.

(c) In reviewing your data from Part III of the lab, explain why the bogo-sort is an example of an exponential complexity algorithm in which the computer “hits the wall.”

¹Janet Davis contributed this problem.