SAN FRANCISCO STATE UNIVERSITY
Computer Science Department

CSC510 Section 04 – Analysis of Algorithms
Algorithm Challenge 3: Dynamic Programming

Instructor: Jose Ortiz

Due on Tuesday November 3 2020 before class

Full Name: _____
Student ID: _____

Assignment Instructions. Must read!

Note: Failure to follow the following instructions in detail will impact your grade negatively.

1. This algorithm challenge is worth 10%, and will be graded using a grading point scale where the maximum possible grade is 100 points. For instance, if your grade in this assignment is 85/100, then this is equivalent to 0.85*10%=8.5% of 10%

2. Take into account that in this type of assignments, I am more interested in the way you approach the problem rather than your final solution.

3. In this algorithm challenge, you don't need to write working code; only pseudocode

Problem Statement

You are an electrician contractor, and you just finished a very specialized job that used wires with a very specific gauge (amp capacity). Projects that need that type of wire are very difficult to get. Therefore, you have decided to sell all the extra wire to get some profit. What is the maximum profit you can get if you sell $N(ft)$ of wire (sold per foot)?

For example: given a list of prices (in dollars) $P = [9, 8, 5, 3]$ per ft, where the $(indexes + 1)$ of those prices represent the number of ft, find the maximum profit for selling 3 ft of wire.

From the above data, we know that 1ft = \$9, 2ft = \$8, 3ft = \$5, and 4ft = \$3 Then, 3ft of wire can be sold in any of the following ways:

- 3ft = \$5
- 1ft + 2ft = \$9 + \$8 = \$17
- 1ft + 1ft + 1ft = \$9 + \$9 + \$9 = \$27

Therefore you will get the maximum profit from 3ft of wire if you sell them in pieces of 1ft.

Your work starts here

1. (50 points) Given list of prices $P = [p_1, p_2, p_3, ..., p_n]$ and a random number of ft where $0 < ft \leq n$, describe the algorithm to solve the problem using the following two approaches (including an educated guess of their time complexities):

   (a) Brute Force

   (b) Dynamic programming

2. (10 points) Write the pseudocode that represents your algorithm used in your dynamic programming approach. **Note pseudocoding is not the same as coding. In this challenge you are not required to code.**

3. (20 points) Based on your pseudocode from part 2, compute the complexity function and time complexity of the dynamic programming algorithm (using the substitution method) and then check your results with the Master Theorem. How correct was your educated guess based on your final results?

4. (20 points) Modify your algorithm from part 1 (Dynamic Programming) so now you must compute the maximum profit you can get if you sell **all the wire**. Will this modification, in the dynamic programming algorithm, change the time complexity you got from part 3? Explain.