EE360C: Algorithms
The University of Texas at Austin — Quiz #5
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Quiz #5

Problem 1: Greedy Algorithm

You are given a sequence of n songs where the i_{th} song is l_i minutes long. Your want to place all of the songs on CDs where each CD can hold m minutes(m is bigger than any l_i). Furthermore,

- The songs must be recorded in the given order, song 1, song 2, ..., song n.
- Each CD could be recorded only once.
- No song may be split across CDs.

Your goal is to determine how to place them on the CDs as to minimize the number of CDs needed. Give the most efficient algorithm you can to find an optimal solution for this problem, prove the algorithm is correct.

Solution

Using greedy choice to record as much songs as possible into each CD when storing the songs in sequence. Assuming the greedy choice records g_0, g_1, ... , g_m numbers of songs on CDs and an optimal strategy records o_0, o_1, ... , o_n numbers of songs on CDs, we now prove that the greedy choice use no more CDs than the optimal strategy. If $g_0 != o_0$, then g_0 must be bigger than o_0 because g_0 uses greedy strategy. For the optimal strategy, if we get some songs(in sequence) in the next CD1 to the current CD0 making CD0 to have the greedy choice, then the optimal strategy will be changed to g_0, o_1', o_2... , o_n where o_1' will be no bigger than o_1, and it's still an optimal choice. Do this inductively, we can replace the optimal choice o_0, o_1, ... , o_n to the greedy choice g_0, g_1, ... , g_m while maintain the choices to be optimal.