CS 341, Fall 2017 A. Lubiw, B. Ma, E. Zima

PROGRAMMING ASSIGNMENT 2

DUE: Wednesday November 1, 7 PM. DO NOT COPY. ACKNOWLEDGE YOUR SOURCES.

Please read `http://www.student.cs.uwaterloo.ca/~cs341` for general instructions and policies.

1. [20 marks] **Dynamic Programming.** Consider the variation of the Knapsack problem from Assignment 5. There are two knapsacks that have capacity $W_1 > 0$ and $W_2 > 0$, respectively. There are n items $1, 2, \ldots, n$. Item i has weight $w(i) > 0$ and two values $v_1(i) > 0$ and $v_2(i) > 0$. Here $v_k(i)$ is the value one gains by putting item i into knapsack k ($k = 1, 2$). The "Two Knapsacks Problem" is to find two *disjoint* subsets of items S_1 and S_2, such that

   1. $\sum_{i \in S_1} w(i) \leq W_1$,
   2. $\sum_{i \in S_2} w(i) \leq W_2$, and
   3. $V = \sum_{i \in S_1} v_1(i) + \sum_{i \in S_2} v_2(i)$ is maximized.

   Give a dynamic programming algorithm to solve the two knapsacks problem.

   The input consists of five lines.

   The first line is a single positive integer indicating the number of items n. The second line has two positive integers that are W_1 and W_2. The third line has n whitespace delimited positive integers for $w(i)$, $(i = 1, 2, \ldots, n)$. The fourth line has n whitespace delimited positive integers for $v_1(i)$, $(i = 1, 2, \ldots, n)$. The fifth line has n whitespace delimited positive integers for $v_2(i)$, $(i = 1, 2, \ldots, n)$.

   The output contains three lines. The first line is the maximum value V one can achieve. The second line is a list of whitespace delimited numbers indicating the items in subset S_1. The third line is a list of whitespace delimited numbers indicating the items in subset S_2. The item numbers in the second and third lines are to be sorted in the increasing order.

   For example, for the following input:

   ```
   4
   5 6
   6 3 2 1
   1 4 7 2
   9 3 3 2
   ```

   the output is:

   ```
   20
   2 3
   1
   ```

   Note that the item labels start with 1.