Homework Assignment #8
Due: November 12, 2015 at 4:00 p.m.

1. Professor Hummelsberger teaches a university course on Tree Climbing. During the semester, there is one class per week for W weeks, and each class is L minutes long. The course contains a series of topics (tree hazard assessment, line placement, how to climb up, how to climb down, etc.). In total there are n topics $T_1, T_2, \ldots, T_n$. The length of class time required to teach topic T_i is ℓ_i minutes (for $1 \leq i \leq n$). You may assume that ℓ_i is an integer between 1 and L. The topics must be covered in order, since each builds upon the previous one. Professor Hummelsberger can cover more than one topic during a single class. The total length of time for all the topics ($\sum_{i=1}^{n} \ell_i$) is less than LW, so Professor Hummelsberger will let his students leave class early on some days or might even cancel some classes.

(a) Professor Hummelsberger prefers not to split a topic across two classes. Use dynamic programming to design an algorithm to determine the minimum number of topics that must be split across two classes during the semester. Try to make your solution efficient. You may assume that L is much bigger than n and W.

Start by defining what the elements of your array represent. Give the recurrence (including base cases) to compute entries of the array. Give pseudocode for filling in the elements of the array and outputting the final answer.

(b) Implement your algorithm from part (a) in C, C++ or Java and submit it electronically. Input to your programme will be given (via the keyboard) in the following format.

The input for your programme will contain data for more than one course. (Once Professor Hummelsberger's colleagues found out about your algorithm, they wanted to use it for their courses too.) The input will be formatted as follows. The first line of input will contain a single integer k, giving the number of courses. Then, for each course, there will be a single line containing three integers L, W and n, followed by n integers $\ell_1, \ell_2, \ldots, \ell_n$. There is a single space between successive integers.

Your programme's output should be formatted as follows. For each course print (on a separate line) the minimum number of topics that must be split across multiple classes.

Use `submit 3101 A8 filename` to submit your programme (see assignment 6 for more detailed instructions). Your solution should be titled `A8.c`, `A8.cc` or `A8.java`. Before submitting your programme, you should test it on the files `A8.in` and `A8.out`, provided on the course web page, as described in the Assignment 6 instructions.

(c) What is the running time of your algorithm in part (a)? State your answer in terms of W, L, and/or n using Θ notation. Briefly explain why your answer is correct.

(d) Give pseudocode that uses the array computed in (a) to print out an optimal syllabus. The syllabus should specify which topics will be taught each week. If there is more than one optimal syllabus, you may print out any one of them.