ESO207: Data Structures and Algorithms

Programming Assignment *1* *Due: June 9, 2017*

Problem 1. Implement FFT and its inverse

The problem asks you to write code to implement the recursive FFT algorithm and FFT inverse algorithm discussed in the class. Your program should start by taking an input 0 or 1. If input is 0, this means that the FFT algorithm has to be run, and the input that follows is of the form
$n\ a_0\ b_0\ a_1\ b_1\ \ldots\ a_{n-1}\ b_{n-1}$
where n (integer) is the degree bound of the input polynomial and the pair $a_j\ b_j$ (floating point numbers) specifies the complex number $c_j = a_j + ib_j$ as the coefficient of x^j of the input polynomial. Thus, the input polynomial is $A(x) = \sum_{j=0}^{n-1} c_j x^j$.
If the first input is 1, this means that the inverse FFT is required and the input that follows is n, the degree-bound, and the coefficients of some DFT are given. The format is the same as before:
$n\ y_0\ z_0\ y_1\ z_1\ \ldots\ y_{n-1}\ z_{n-1}$
where, the pair $y_j\ z_j$ specifies the complex number $y_j + iz_j$ to be $A(\omega_n^j)$, for some polynomial A, that is, it is the jth coordinate of a given DFT. Once the input is specified, your program should compute the FFT or the inverse FFT as requested and present the output in vector form.

Example:
Input:
0 4 0 0 1.0 0 2.0 0 3.0 0
Output:
4 6.0 0 -2.0 -2.0 -2.0 0 -2.0 2.0

That is, the DFT of $x + 2x^2 + 3x^3$ is the vector $[6, -2 - 2i, -2, -2 + 2i]$

Example:
Input:
1 4 6.0 0 -2.0 -2.0 -2.0 0 -2.0 2.0
Output:
4 0 0 1.0 0 2.0 0 3.0 0

That is, the DFT^{-1} of the vector $[6, -2 - 2i, -2, -2 + 2i]$ is the polynomial $x + 2x^2 + 3x^3$.