**Yuan Gao z5239220 Q3**

Assume you are given a map of a straight sea shore of length meters as a sequence on numbers such that is the number of fish between meter of the shore and meter,. You also have a net of length n meters but unfortunately it has holes in it. Such a net is described as a sequence of ones and zeros, where 0’s denotes where the holes are. If you throw such a net starting at meter k and ending at meter , then you will catch only the fish in one meter stretches of the shore where the corresponding bit of the net is 1. Find the spot where you should place the left end of your net in order to catch the largest possible number of fish using an algorithm which runs in time .

According to the question, there are:

Straight seashore (vector):

Net (step length):

Weight: where



Let C as catch the number of fish:

That is the number of caught fish started and end of .

Thus, we can think of and as two polynomials and do convolution.

Because we need the forward match, net vector should be inverted. ( as reverse order of net array).

Hence, we can get a vector from , and the maximum value of can be the largest possible number of fish.

The brute force algorithm of would be , therefore we use FFT to reduce time complexity.

Firstly, there are the formula of DFT and IDFT

Let the net as an example:

Assume

There is vector can be spilt to

Square , we have

Then,

We can get:

Now we change to complex roots of unity

There are

According to Cancelation Lemma and Elimination Lemma

We can start by divide and conquer

This step

And by the same logic

The time complexity is

According to the formula of IDFT

Changing the to of complex roots of unity the IDFT can be done

Hence,



Then, we just cost O(n) to find the maximum value in vector

The total time complexity is