Q3

First, we should know if we do continuously inner product, time complexity would be $O(n^2)$. Look at the figure and combine the lecture slides, we use convolution.

Let N' be the net sequence N in the reverse order. So we can do convolution of the sequence $C = A * N'$, in order to do convolution, we first transfer sequence form to $P_A(x)$, $P'_N(x)$, then compute the DFT followed by multiplication, and then use inverse transformation for DFT to recover the coefficients of the product polynomial $P_C(x)$, thus, we got the sequence of C. The sequence like

$C_0 = A_0 * N_0$

$C_1 = A_0 N_1 + A_1 N_0$

$\ldots$

$C_{k+m} = A_k N_m + A_{k+1} N_{m-1} + \cdots + A_{k+m} N_0$

$\ldots$

$C_{m+n} = A_n N_m$

So that we can get a sequence of fish numbers with length $100n + 10$. What we do is just use for loop to find the largest possible number of fish in time $O(n)$. And we know convolution in time $O(nlogn)$.

Thus, total time runs in $O(nlogn) + O(n)$ which is $O(nlogn)$.