ChatGPT 4o

Since we zero-padded to length 4, we're working with a vector length $n = 4$, and we'll use the 4th roots of unity in the inverse direction to perform the inverse FFT.

The inverse FFT formula for a sequence $C' = [C'(0), C'(1), C'(2), C'(3)]$ is:

$$C(k) = \frac{1}{n}\sum_{j=0}^{n-1} C'(j) \cdot \omega_n^{-jk}$$

where:

- $n = 4$,
- ω_n^{-1} is the inverse root of unity, specifically $e^{-2\pi i/4} = i$,
- We need to divide by $n = 4$ at the end to normalize.

The 4th roots of unity (for $n = 4$) in the inverse FFT are:

- $\omega_0^{-1} = 1$
- $\omega_1^{-1} = -i$
- $\omega_2^{-1} = -1$
- $\omega_3^{-1} = i$

Let's calculate each $C(k)$ for $k = 0, 1, 2, 3$.

Calculation of Each $C(k)$

Step 1: Calculate $C(0)$

$$C(0) = \frac{1}{4}\left(C'(0) \cdot \omega_0^{-1} + C'(1) \cdot \omega_0^{-1} + C'(2) \cdot \omega_0^{-1} + C'(3) \cdot \omega_0^{-1}\right)$$

Since $\omega_0^{-1} = 1$, this becomes:

$$C(0) = \frac{1}{4}(6 + (1 + 3i) + 0 + (1 - 3i)) = \frac{1}{4}(6 + 1 + 3i + 1 - 3i)$$

$$C(0 \quad \frac{1}{4} \cdot 8 = 2$$

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