FFTW
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Representation of Problems

I/O dimension \( d = (n, i, o) \) (length, input stride, output stride)

I/O tensor \( t = (d_1, d_2, \ldots, d_\rho) \) A set of I/O dimensions

Rank \( \rho = |t| \)

\[ d = (n, i, o) \]
\[ Y[k] = \sum_{j=0}^{n-1} X[j] \omega_n^j \quad \omega_n = e^{-j2\pi/n} \quad n = n_1n_2 \quad 0 \leq k < n \quad 0 \leq j < n \]

\[ k = k_1 + k_2n_1 \quad 0 \leq k_1 < n_1 \quad 0 \leq k_2 < n_2 \]

\[ j = j_1n_2 + j_2 \quad 0 \leq j_1 < n_1 \quad 0 \leq j_2 < n_2 \]

\[ Y[k_1 + k_2n_1] = \sum_{j_2=0}^{n_2-1} \sum_{j_1=0}^{n_1-1} X[j_1n_2 + j_2] \omega_{n_1n_2}^{(k_1 + k_2n_1)(j_1n_2 + j_2)} \]

\[ (k_1 + k_2n_1)(j_1n_2 + j_2) = k_1j_1n_2 + k_2j_1n_1n_2 + k_1j_2 + k_2j_2n_1 \]

\[ \omega_{n_1n_2}^{(k_1 + k_2n_1)(j_1n_2 + j_2)} = \omega_{n_1n_2}^{k_1j_1n_2} \cdot \omega_{n_1n_2}^{k_2j_1n_1n_2} \cdot \omega_{n_1n_2}^{k_1j_2} \cdot \omega_{n_1n_2}^{k_2j_2n_1} \]

\[ = \omega_{n_1}^{k_1j_1} \cdot \omega_{n_2}^{k_1j_2} \cdot \omega_{n_1}^{k_2j_2} \cdot \omega_{n_2}^{k_2j_2} \]

\[ Y[k_1 + k_2n_1] = \sum_{j_2=0}^{n_2-1} \left[ \left( \sum_{j_1=0}^{n_1-1} X[j_1n_2 + j_2] \omega_{n_1}^{k_1j_1} \right) \omega_{n_2}^{k_1j_2} \right] \omega_{n_2}^{k_2j_2} \]
DFT (2)

\[ Y[k_1 + k_2 n_1] = \sum_{j_2=0}^{n_2-1} \left[ \sum_{j_1=0}^{n_1-1} X[j_1 n_2 + j_2] \omega_{n_1}^{k_1 j_1} \omega_{n_2}^{k_1 j_2} \right] \]

n_2 DFT of size n_1 \hspace{1cm} n_1 DFT of size n_2
Message Aggregation
References