The sum is a linear convolution after including the negative-index chirp and padding to at least $2N-1$. This proves that a power-of-two convolution backend can compute the exact length-N DFT. A robust FFT library already incorporates efficient non-power-of-two algorithms; the delivered default uses it.

Comparative cost and preferred method

The direct defining sum uses N^2 products and $N(N-1)$ additions. Chirp convolution uses $O(N \log N)$ arithmetic with $O(N)$ workspace. The production library is the strong control; the explicit chirp implementation is explanatory and is not claimed faster. MATLAB execution is not asserted in this environment; the supplied routine and the executed Python equivalent are distinguished.