Structural or analytic derivation

Multiplication by $(1-z)^{-1}$ is the discrete integration operator on coefficient sequences. It adds one simple pole at one to the Fibonacci resolvent, exactly accounting for the constant correction in $F_{n+2}-1$.

Comparative cost and preferred method

Computing each prefix sum independently uses $\Theta(N^2)$ additions for N outputs. One cumulative pass uses $\Theta(N)$, and the formula gives a remote value with a fast Fibonacci algorithm in $O(\log n)$ coefficient multiplications. The strongest standard cumulative-sum algorithm matches the linear prefix complexity; the generating function provides a proof and remote-query formula.