Structural or analytic derivation

With zero initial state, the corresponding transfer functions are $Tz^{-1}/(1-z^{-1})$, $T/(1-z^{-1})$, and $\frac{T}{2}(1+z^{-1})/(1-z^{-1})$. The trapezoidal relation equates the continuous integrator $1/s$ with the last rational function, yielding $s=(2/T)(1-z^{-1})/(1+z^{-1})$. The pole at one records integration and the failure of an unrestricted BIBO bound on an infinite time horizon.

Comparative cost and preferred method

All three schemes require constant work and one state per sample. On a fixed time interval, trapezoidal error is $O(T^2)$ while rectangle error is $O(T)$ under the stated differentiability assumptions. For tolerance ϵ, the respective sufficient sample counts scale as $\epsilon^{-1/2}$ and ϵ^{-1}, with their derivative constants included. This is an accuracy-cost comparison, not a universal measured timing ratio.