Compression Scaling Law — Methods (Step-by-Step)

Data preparation

• Input scalar time series $x(t)$; z-score per window; optional detrend. • Choose window sizes L (e.g., 48–192) and step (e.g., 16).

Quantization & coding

• Quantizer Q: μ-law, 8-bit (fixed). • Coder $\blacksquare$: lossless (DEFLATE/bzip2/LZMA). Measure bits/symbol.

Surrogates

• IAAFT (spectrum + marginal preserved) as default. • Sensitivities: AR(p), STFT-phase magnitude-preserving.

Contrast & scaling

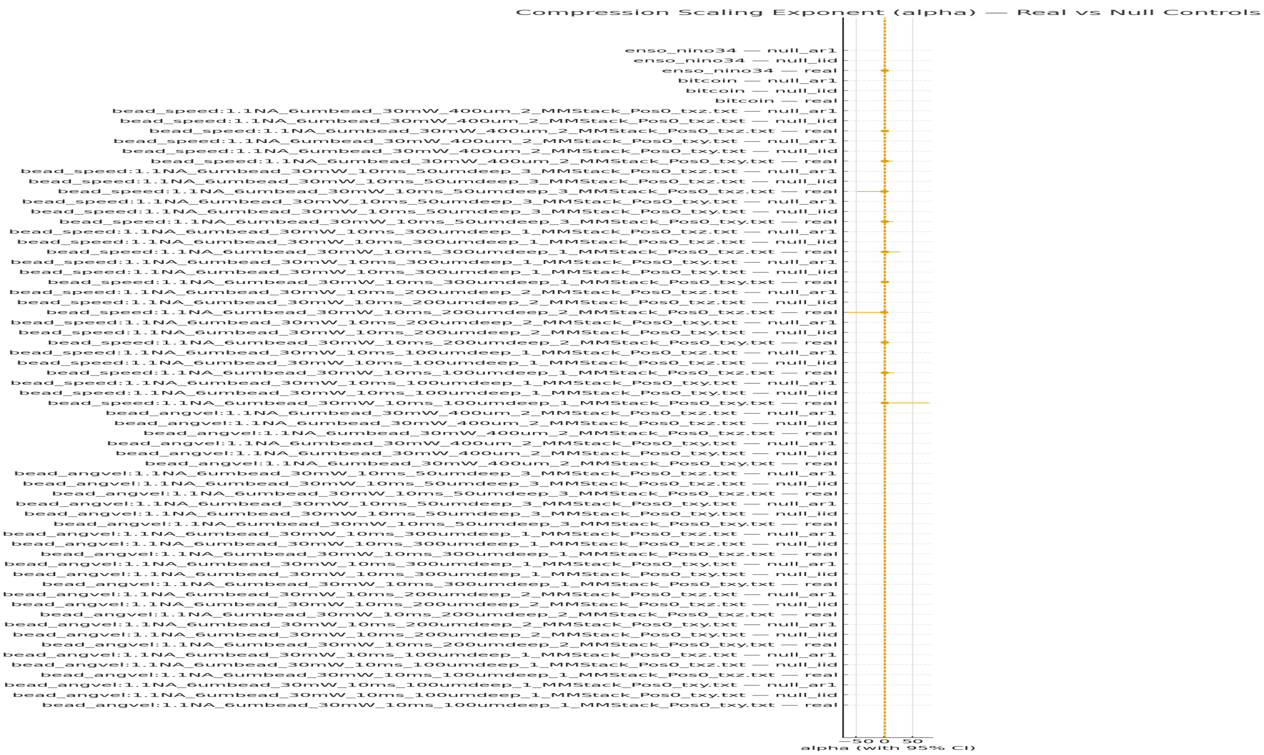
• For each L and start s: $\Delta(L,s) = \blacksquare(Q(x[s:s+L])) - \blacksquare(Q(surr[s:s+L]))$. • Average: $\Delta\blacksquare(L)$; define $\kappa(L) = -L\cdot\Delta\blacksquare(L)$. • Fit $\log \kappa(L) = a + b \log L$; $\alpha = 1 - b$.

Uncertainty & diagnostics

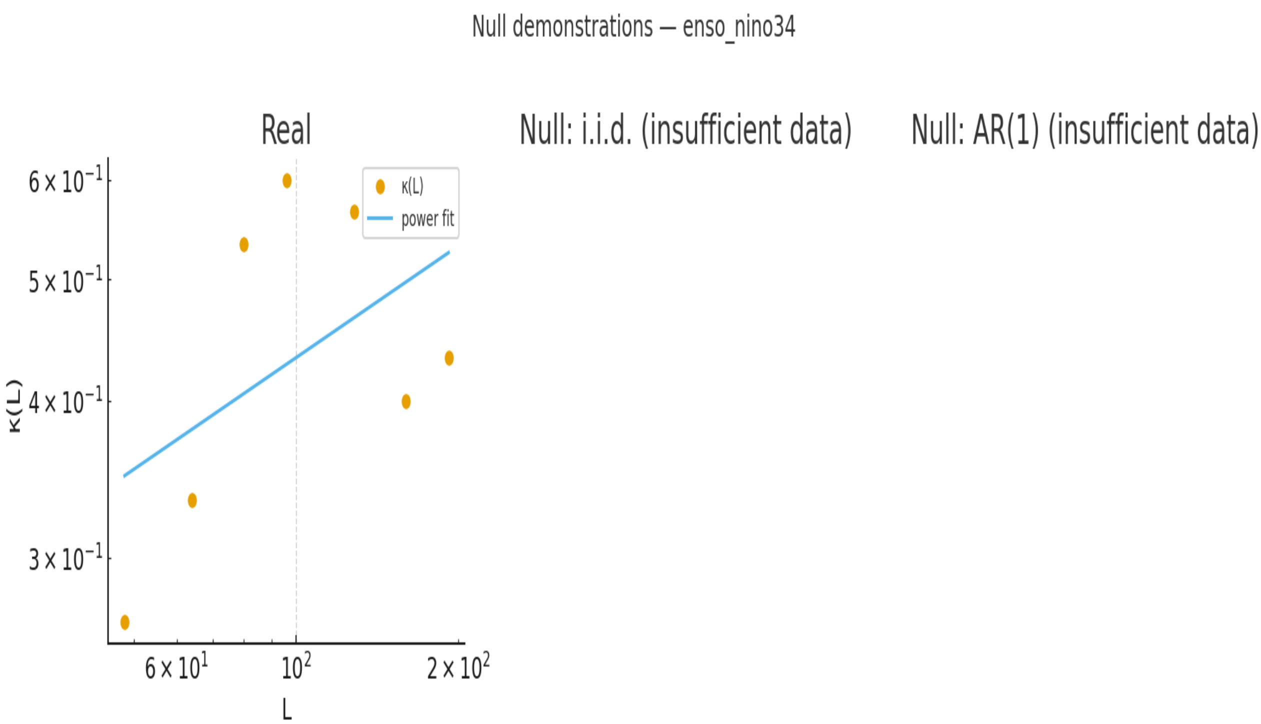
• Block bootstrap across starts (BL≈6) for 95% CI of α. • Compare power vs log vs exp vs broken-power using AICc/BIC. • Residual checks on $\log \kappa(L)$.

Controls & falsification

• Nulls (i.i.d., AR(1)) should give $\alpha \approx 1$. • Falsify if exp/log routinely beat power in BIC, or α shifts across coders/surrogates beyond CI.



Example α (95% CI) across datasets and nulls.



Null panels for a macro dataset (real vs i.i.d. vs AR(1)).