■ Random Walk & Correlations Demo (1D Space–Time + Time Series)

Overview

• Visualizes a 1D random walk where a stick figure moves left or right while moving upward in time.
• Each step represents a decision — “go left” (–1) or “go right” (+1).
• The right panel shows the displacement time series x(t).

■■■■ Left Panel: Space–Time Diagram

• X-axis: Position (displacement from the origin).
• Y-axis: Time (each upward step is one time increment).
• The stick figure shows current position.
• Faint white trail marks previous positions.

■ Right Panel: Time Series

• Plots displacement x(t) versus time t.
• Updates dynamically as the figure moves.
• Used to compute statistical properties of the walk.

■■ Noise / Correlation Options

• White noise: Uncorrelated, pure randomness (standard random walk).
• Pink noise (1/f): Moderate long-range correlation.
• Sinusoidal: Periodic, deterministic oscillation.
• LRTC (+): Long-range positive correlation → persistent (tends to continue direction).
• LRTC (–): Long-range negative correlation → anti-persistent (tends to reverse direction).

■ Computed Statistics

• DFA exponent (α): Estimated using Detrended Fluctuation Analysis (like nolds.dfa).
• Measures fractal correlation strength: $\alpha \approx 0.5 \rightarrow$ uncorrelated, $\alpha > 0.5 \rightarrow$ persistent, $\alpha < 0.5 \rightarrow$ anti-persistent.
• ACF 0.5 Lag: The lag (steps) where the autocorrelation first drops to 0.5, showing memory length.

■ Key Learning Points

• Random walks can exhibit different correlation structures, not all are purely random.
• The DFA exponent quantifies self-similarity and long-term dependence.
• The autocorrelation half-life complements DFA by showing short-term memory.
• The animation connects statistical measures with intuitive motion.