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Synthesizing Chaos JONATHAN BLAKELY, NED CORRON, SCOTT HAYES, SHAWN PETHEL, US Army RDECOM — Chaos is usually attributed only to nonlinear systems. Yet it was recently shown that chaotic waveforms can be synthesized by linear superposition of randomly polarized basis functions. The basis function contains a growing oscillation that terminates in a large pulse. We show that this function is easily realized when viewed backward in time as a pulse followed by ringing decay. Consequently, a linear filter driven by random pulses outputs a waveform that, when viewed backward in time, exhibits essential qualities of chaos, i.e. determinism and a positive Lyapunov exponent. This phenomenon suggests that chaos may be connected to physical theories whose framework is not that of a deterministic dynamical system. We demonstrate that synthesizing chaos requires a balance between the topological entropy of the random source and the dissipation in the filter. Surprisingly, using different encodings of the random source, the same filter can produce both Lorenz-like and Rössler-like waveforms. The different encodings can be viewed as grammar restrictions on a more general encoding that produces a chaotic superset encompassing the Lorenz and Rössler paradigms of nonlinear dynamics. Thus, the language of deterministic chaos provides a useful description for a class of signals not generated by a deterministic system.

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