Limits to Predictability in 2000 and 2100

LA Smith

Proceedings of IEEE 2000 Adaptive Systems for Signal Processing, Communications, and Control Symposium, ed. S. Haykin, 129-134, 2000

Abstract

Deterministic chaos is widely thought to place the ultimate limit on our ability to forecast. While chaos certainly limits our ability to predict precise outcomes in the perfect model experiments of which theorists are most fond, this paper explores the role of uncertainty in real physical systems: a simple nonlinear circuit, the weather next week, and the Earth's climate system. Here model error, not uncertain observations, may pose the more fundamental limit to prediction; this is true whether one prefers stochastic or deterministic models. A crucial difference between the circuit and the atmosphere is one of time scales: the duration over which we can observe the circuit seems long in terms of all of its natural periods, never-the-less it is error in our model(s) that prevents reliable forecasts. How should we model physical systems on time scales over which we know our models are flawed? How might we predict the weather, climate and nonlinear circuits in 2100? Will we have deployed 'improved techniques'? Or will we have altered our aims in understanding and predicting nonlinear systems?