Predictability and Control Issues in Complex Dynamical Systems*

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Dynamical systems in chaotic regimes display very high sensitivity to perturbations. This feature has two main practical consequences, namely: (i) one negative, related to predictability and (ii) the other one positive, related to control. Indeed, due to the exponential divergence of initially close trajectories, information about the state of the system is rapidly lost, and - even in the absence of stochasticity - detailed long range predictability becomes impossible. On the other hand, the same high sensitivity makes it possible to affect the dynamics by applying only very minute controls. The former phenomenon has been first intuited and quasi-predicted by Poincare in his treatise on celestial mechanics; since Lorenz's 1963 seminal paper, it has since become a fixture of chaotic dynamics. The latter aspect has been used in many control schemes, including OGY, feedback, etc. Here we briefly summarize several new results and ideas related to predictability and control in dynamical systems. First we present a model-independent method for timely forewarning of unusual events in complex systems. This method has been successfully applied to physiological and industrial machine data and shown to outperform traditional nonlinear methods. Second, we present a new, robust control algorithm for dynamical systems that is based on non-Lipschitzian dynamics. The algorithm does not necessarily target all dynamical variables, but only global variables of interest. The algorithm has been successfully implemented for a nano-friction model, but has general applicability.

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