

Numerical Analysis of Dynamical Systems

John Guckenheimer *

October 5, 1999

1 Introduction

This paper presents a brief overview of algorithms that aid in the analysis of dynamical systems and their bifurcations. The viewpoint is geometric and the goal is to describe algorithms that reliably compute objects of dynamical significance. Reliability has three facets:

1. the probability that the algorithm returns an answer for different choices of starting data,
2. whether the computed object is qualitatively correct, and
3. the accuracy with which the objects are computed.

Numerical analysis has traditionally concentrated on the third of these topics, but the first two are perhaps more important in numerical studies that seek to delineate the structure of dynamical systems.

This survey concentrates on exposition of fundamental mathematical principles and their application to the numerical analysis of examples. There is a strong interplay between dynamical systems theory and computational analysis of dynamical systems. The theory provides a framework for interpreting numerical observations and foundations for algorithms. Apparent discrepancies between computational output and theoretical expectations point to areas where phenomena have been overlooked in the theory, areas where algorithms produce misleading results, and areas where the relationship between theory and computation is more subtle than anticipated. Several examples of simple systems are used in this article to illustrate seeming differences between computation and theory.

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Dynamical Systems And Numerical Analysis

Jin-Ying Zhang



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