Deterministic Chaos – Complex Chance out of Simple Necessity

A Lively Introduction to Chaos

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Ravindra E Amritkar

Deterministic Chaos – Complex Chance out of Simple Necessity
N Kumar
Universities Press (India), Hyderabad
1996, pp.96+14, Rs. 70.

This is a very lucid and lively book on deterministic chaos. Chaos is very common in nature. However, the understanding and realisation of its potential applications is very recent. Thus this book is a timely addition to the subject. There are several books on chaos and several more are being added every day. In spite of this explosion of publications the book by Kumar is unique in the sense that it contains reasonable scientific details without losing a broad readership.

The book is targeted at undergraduate and postgraduate students and teachers with scientific background. It may also be useful as a text at the B.Sc or the B. Tech level and for the introductory part at the M.Sc level. It is also suitable for those with a general interest in scientific developments. The first four chapters are less technical and one may be able to grasp the basic concepts by reading them.

One difficulty in using the book as a text may be that there are no problems or exercises. Thus it will be necessary to use supplementary books for problems.

The presentation of the book is very good. Difficult concepts are explained in very simple language, e.g. the discussion of phase locking in section 3.2. For almost every new concept numerous physical and natural examples are given. This gives a clear understanding of these concepts and more importantly it has made the whole discussion very appealing and lively. There are several graphical illustrations throughout the book. The style of presentation maintains a smooth flow.

The book has concentrated on important aspects of chaos and has omitted unnecessary details. The choice of topics is good and topics such as quantum chaos are left for advanced reading.

In spite of its simplicity, the book is technically accurate. One place where the reader may have some problems is the Bernoulli shift (page 6) where the author advises the audience to try it on a computer/calculator. However, the author has forgotten to mention that the value two of the slope gives periodic orbits on a computer/calculator due to finite

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accuracy of the calculations. A way out may be to use 1.99999... as the slope.

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Summary of Contents

The book discusses a variety of topics. The first chapter gives a nontechnical introduction to important concepts such as deterministic laws of nature, sensitive dependence on initial conditions (butterfly effect), non-linearity, folding etc. Several real life examples are given. There are several interesting quotes in this chapter. The second chapter introduces some basic concepts from physics and mathematics required in the understanding of chaos like phase space and flows, dissipative and conservative systems, Poincaré section etc.

Two simple important discrete models, namely logistic and circle maps, are discussed

in chapter three. The concept of universality (period doubling) is introduced. The discussion of mode-locking is probably the most lucid in the book. The chapter also discusses bifurcations, intermittency and some important routes to chaos. Chapter four is a short discussion of the most important concept of strange attractors involving divergence and confinement. This is illustrated using the famous Lorenz attractor. Chapter five deals with the more specialised topic of chaos in Hamiltonian systems. It discusses the concepts of invariant tori and their stability (KAM theorem). Several well known examples such as standard map, twist map, pendulum etc are used. To understand this chapter some background in Hamiltonian dynamics may be useful.

The sixth chapter is devoted to the characterisation of chaos. Some measures of chaos, namely fractal dimension and multifractals, are introduced. The important concept of embedding a time series in higher dimensions leading to reconstruction of the chaotic attractor is discussed. The concluding chapter of the book discusses several applications and future directions of progress. Some important topics and technical details are covered in the appendices. These details are important in understanding chaos and should not be omitted.

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