



RECHERCHE

A DIGEST OF MULTIDISCIPLINARY EXPLORATIONS
(PEER REVIEWED)



R D

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Baker Map and its Dynamical Properties

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Abstract

The study of dynamical systems and mostly the study of chaotic systems are important breakthroughs of current mathematical research. Baker map, that is a simple two dimensional map, is useful for describing many of the concepts for characterizing chaos. In this paper, some of the properties of one and two dimensional Baker maps are discussed.

Keywords: Fixed point, periodic orbits, chaos.

2010 Mathematics Subject Classification: Primary 28A80; Secondary 11B05.

1 Introduction

The characteristics of dynamical boundary which are extremely sensitive to initial conditions are explained by chaos theory. Chaotic systems are mathematically deterministic yet erratic due to their sensitivity to initial conditions. Because of the topological transitivity, it is impossible to decompose chaotic maps into two subsystems which do not intersect under the map. Despite of all these random behaviour, chaotic systems show a regularity element called periodic points that are dense.

Chaos theory originated with the work of Edward Lorenz. His attention in chaos arose by chance as a result of his work on weather prediction in 1961 [1]. But a precise mathematical definition of chaos is given by Tien-Yien Li and James. A Yorke in 1975 [2]. In 1989, R.L.Devaney [3] defined chaotic functions in general metric spaces, which became popular. More related works can be seen in [5]-[8]. There are three conditions namely transitivity, dense set of periodic points and sensitive dependence for a function to be chaotic.

In 2013, Wadia Faid Hassan Al-shameri and Mohammed Abdulkawi Mahiub [4] investigated certain dynamical features of different types of tent maps. Tent map is a chaotic map and because of its uncomplicated structure, pattern of tent map under iteration can be comprehended effectively. Tent map is topologically conjugate to baker map. Having this in mind, an analogous study on some dynamical properties of baker map is done in this article.

2 Preliminaries

This section contains fundamental definitions that are required for the formation of this article.

Definition 2.1. Let $\psi : \mathbb{R} \rightarrow \mathbb{R}$ be a function. A point $x \in \mathbb{R}$ is called a fixed point of ψ if $\psi(x) = x$. The point x is a periodic point of period m if $\psi^m(x) = x$ for $m \in \mathbb{N}$. The smallest positive integer m such that $\psi^m(x) = x$ is known as the prime period of x .

Definition 2.2. Let I denotes an interval, and let $\psi : I \rightarrow I$ be a map. Then ψ has sensitive dependence on initial conditions at x , if there is an $\epsilon > 0$ such that for each $\delta > 0$, there is a x' in I and a positive integer m such that

$$|x - y| < \delta \quad \text{and} \quad |\psi^m(x) - \psi^m(x')| > \epsilon$$

If the above condition is true for every $x \in I$, then ψ has sensitive dependence on initial conditions on I [6].

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