Introduction

"Finite automaton" and "sequential machines" are two traditional terms that are widely used to designate a very simple class of dynamical systems. The theory of this class evolved as a separate entity for the following two reasons:

1. These dynamical systems are frequently employed in technology, particularly in automatic and remote control and computer engineering (digital computers are a special case of this class). The needs of modern technology have therefore prompted an intensive study of the general relationships governing this class, in order to develop methods of analysis and of optimal synthesis of these dynamical systems.

2. The continuing progress in science and technology, particularly in computers, increasingly poses questions such as: What can a machine "do" and what is it incapable of "doing"? Could a machine perform any algorithm? In principle, could a machine do something more than merely execute an algorithm? To what extent is a machine capable or incapable of performing functions characteristic of a human brain? All attempts at exact formulation of these questions, let alone finding the answers, hinge upon our definition of the term "machine." As of now, it is impossible to solve these problems in terms of a very broad class of dynamical systems. If, however, we define a machine as a restricted class of such systems—that known as "finite automata" and "sequential machines"—then the questions make sense. They can be exactly formulated and, in some cases, answered.

There is another reason, peculiar to our present state of knowledge, which helps maintain interest in systems of this class. The brain consists of a very large number of nerve cells, or neurons. By idealizing their properties to some extent, we can construct a mathematical model of the brain—one that is valid, of course, only within the limits of this idealization. This model is also a dynamical system of the type we shall consider. Our expanding knowledge of neurons and of the brain as a whole has shown that the above idealization is inadequate and that more complex models are desirable. Nevertheless, the fact remains that within this idealized framework, which is quite acceptable at our particular stage of knowledge, both the human brain and a general-purpose digital computer can be regarded as belonging to the same comparatively simple class of dynamical systems. It is this fact that lends interest to the study of finite automata and sequential machines.