EXCERPTED FROM

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A NEW KIND OF SCIENCE

SECTION 7.1

Universality of Behavior

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Mechanisms in Programs and Nature

Universality of Behavior

In the past several chapters my main purpose has been to address the fundamental question of how simple programs behave. In this chapter my purpose is now to take what we have learned and begin applying it to the study of actual phenomena in nature.

At the outset one might have thought this would never work. For one might have assumed that any program based on simple rules would always lead to behavior that was much too simple to be relevant to most of what we see in nature. But one of the main discoveries of this book is that programs based on simple rules do not always produce simple behavior.

And indeed in the past several chapters we have seen many examples where remarkably simple rules give rise to behavior of great complexity. But to what extent is the behavior obtained from simple programs similar to behavior we see in nature?

One way to get some idea of this is just to look at pictures of natural systems and compare them with pictures of simple programs.

At the level of details there are certainly differences. But at an overall level there are striking similarities. And indeed it is quite remarkable just how often systems in nature end up showing behavior that looks almost identical to what we have seen in some simple program or another somewhere in this book.

So why might this be? It is not, I believe, any kind of coincidence, or trick of perception. And instead what I suspect is that it reflects a deep correspondence between simple programs and systems in nature.

When one looks at systems in nature, one of the striking things one notices is that even when systems have quite different underlying physical, biological or other components their overall patterns of behavior can often seem remarkably similar.

And in my study of simple programs I have seen essentially the same phenomenon: that even when programs have quite different underlying rules, their overall behavior can be remarkably similar.

So this suggests that a kind of universality exists in the types of behavior that can occur, independent of the details of underlying rules.

And the crucial point is that I believe that this universality extends not only across simple programs, but also to systems in nature. So this means that it should not matter much whether the components of a system are real molecules or idealized black and white cells; the overall behavior produced should show the same universal features.

And if this is the case, then it means that one can indeed expect to get insight into the behavior of natural systems by studying the behavior of simple programs. For it suggests that the basic mechanisms responsible for phenomena that we see in nature are somehow the same as those responsible for phenomena that we see in simple programs.

In this chapter my purpose is to discuss some of the most common phenomena that we see in nature, and to study how they correspond with phenomena that occur in simple programs.

Some of the phenomena I discuss have at least to some extent already been analyzed by traditional science. But we will find that by thinking in terms of simple programs it usually becomes possible to see the basic mechanisms at work with much greater clarity than before.

And more important, many of the phenomena that I consider—particularly those that involve significant complexity—have never been satisfactorily explained in the context of traditional science. But what we will find in this chapter is that by making use of my discoveries about simple programs a great many of these phenomena can now for the first time successfully be explained.