

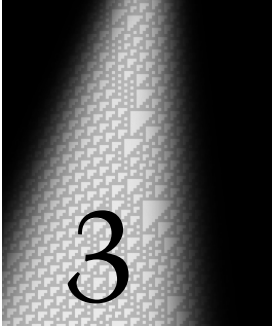


EXCERPTED FROM

STEPHEN
WOLFRAM
A NEW
KIND OF
SCIENCE

SECTION 3.1

*The Search for
General Features*



The World of Simple Programs

The Search for General Features

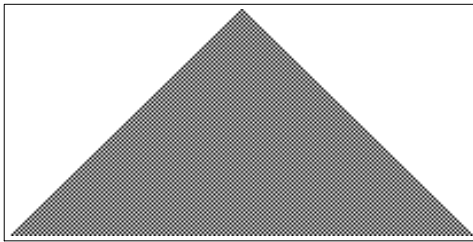
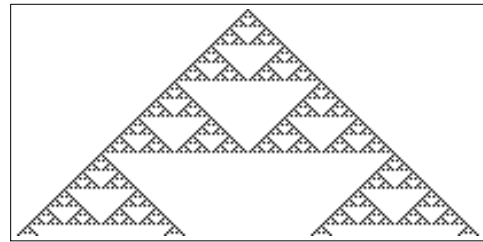
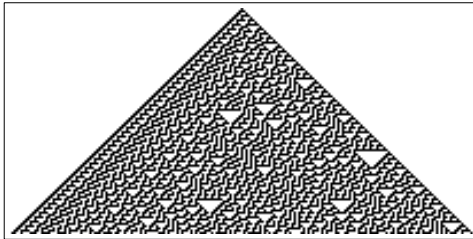
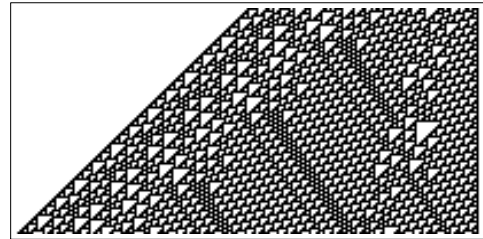
At the beginning of the last chapter we asked the basic question of what simple programs typically do. And as a first step towards answering this question we looked at several specific examples of a class of programs known as cellular automata.

The basic types of behavior that we found are illustrated in the pictures on the next page. In the first of these there is pure repetition, and a very simple pattern is formed. In the second, there are many intricate details, but at an overall level there is still a very regular nested structure that emerges.

In the third picture, however, one no longer sees such regularity, and instead there is behavior that seems in many respects random. And finally in the fourth picture there is what appears to be still more complex behavior—with elaborate localized structures being generated that interact in complex ways.

At the outset there was no indication that simple programs could ever produce behavior so diverse and often complex. But having now seen these examples, the question becomes how typical they are. Is it only cellular automata with very specific underlying rules that produce such behavior? Or is it in fact common in all sorts of simple programs?

My purpose in this chapter is to answer this question by looking at a wide range of different kinds of programs. And in a sense my

*repetition (rule 250)**nesting (rule 90)**randomness (rule 30)**localized structures (rule 110)*

Four basic examples from the previous chapter of behavior produced by cellular automata with simple underlying rules. In each case, the most obvious features that are seen are different. Note that all the pictures are shown on the same scale; the last picture appears coarser because the structures it contains are larger.

approach is to work like a naturalist—exploring and studying the various forms that exist in the world of simple programs.

I start by considering more general cellular automata, and then I go on to consider a whole sequence of other kinds of programs—with underlying structures further and further away from the array of black and white cells in the cellular automata of the previous chapter.

And what I discover is that whatever kind of underlying rules one uses, the behavior that emerges turns out to be remarkably similar to the basic examples that we have already seen in cellular automata.

Throughout the world of simple programs, it seems, there is great universality in the types of overall behavior that can be produced. And in a sense it is ultimately this that makes it possible for me to construct the coherent new kind of science that I describe in this book—and to use it to elucidate a large number of phenomena, independent of the particular details of the systems in which they occur.