



EXCERPTED FROM

STEPHEN
WOLFRAM
A NEW
KIND OF
SCIENCE

SECTION 12.12

Historical Perspectives

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It would be most satisfying if science were to prove that we as humans are in some fundamental way special, and above everything else in the universe. But if one looks at the history of science many of its greatest advances have come precisely from identifying ways in which we are not special—for this is what allows science to make ever more general statements about the universe and the things in it.

Four centuries ago we learned for example that our planet does not lie at a special position in the universe. A century and a half ago we learned that there was nothing very special about the origin of our species. And over the past century we have learned that there is nothing special about our various physical, chemical and other constituents.

Yet in Western thought there is still a strong belief that there must be something fundamentally special about us. And nowadays the most common assumption is that it must have to do with the level of intelligence or complexity that we exhibit. But building on what I have discovered in this book, the Principle of Computational Equivalence now makes the fairly dramatic statement that even in these ways there is nothing fundamentally special about us.

For if one thinks in computational terms the issue is essentially whether we somehow show a specially high level of computational sophistication. Yet the Principle of Computational Equivalence asserts that almost any system whose behavior is not obviously simple will tend to be exactly equivalent in its computational sophistication.

So this means that there is in the end no difference between the level of computational sophistication that is achieved by humans and by all sorts of other systems in nature and elsewhere.

For my discoveries imply that whether the underlying system is a human brain, a turbulent fluid, or a cellular automaton, the behavior it exhibits will correspond to a computation of equivalent sophistication.

And while from the point of view of modern intellectual thinking this may come as quite a shock, it is perhaps not so surprising at the level of everyday experience. For there are certainly many systems in nature whose behavior is complex enough that we often describe it in

human terms. And indeed in early human thinking it is very common to encounter the idea of animism: that systems with complex behavior in nature must be driven by the same kind of essential spirit as humans.

But for thousands of years this has been seen as naive and counter to progress in science. Yet now essentially this idea—viewed in computational terms through the discoveries in this book—emerges as crucial. For as I discussed earlier in this chapter, it is the computational equivalence of us as observers to the systems in nature that we observe that makes these systems seem to us so complex and unpredictable.

And while in the past it was often assumed that such complexity must somehow be special to systems in nature, what my discoveries and the Principle of Computational Equivalence now show is that in fact it is vastly more general. For what we have seen in this book is that even when their underlying rules are almost as simple as possible, abstract systems like cellular automata can achieve exactly the same level of computational sophistication as anything else.

It is perhaps a little humbling to discover that we as humans are in effect computationally no more capable than cellular automata with very simple rules. But the Principle of Computational Equivalence also implies that the same is ultimately true of our whole universe.

So while science has often made it seem that we as humans are somehow insignificant compared to the universe, the Principle of Computational Equivalence now shows that in a certain sense we are at the same level as it is. For the principle implies that what goes on inside us can ultimately achieve just the same level of computational sophistication as our whole universe.

But while science has in the past shown that in many ways there is nothing special about us as humans, the very success of science has tended to give us the idea that with our intelligence we are in some way above the universe. Yet now the Principle of Computational Equivalence implies that the computational sophistication of our intelligence should in a sense be shared by many parts of our universe—an idea that perhaps seems more familiar from religion than science.

Particularly with all the successes of science, there has been a great desire to capture the essence of the human condition in abstract scientific

terms. And this has become all the more relevant as its replication with technology begins to seem realistic. But what the Principle of Computational Equivalence suggests is that abstract descriptions will never ultimately distinguish us from all sorts of other systems in nature and elsewhere. And what this means is that in a sense there can be no abstract basic science of the human condition—only something that involves all sorts of specific details of humans and their history.

So while we might have imagined that science would eventually show us how to rise above all our human details what we now see is that in fact these details are in effect the only important thing about us.

And indeed at some level it is the Principle of Computational Equivalence that allows these details to be significant. For this is what leads to the phenomenon of computational irreducibility. And this in turn is in effect what allows history to be significant—and what implies that something irreducible can be achieved by the evolution of a system.

Looking at the progress of science over the course of history one might assume that it would only be a matter of time before everything would somehow be predicted by science. But the Principle of Computational Equivalence—and the phenomenon of computational irreducibility—now shows that this will never happen.

There will always be details that can be reduced further—and that will allow science to continue to show progress. But we now know that there are some fundamental boundaries to science and knowledge.

And indeed in the end the Principle of Computational Equivalence encapsulates both the ultimate power and the ultimate weakness of science. For it implies that all the wonders of our universe can in effect be captured by simple rules, yet it shows that there can be no way to know all the consequences of these rules, except in effect just to watch and see how they unfold.