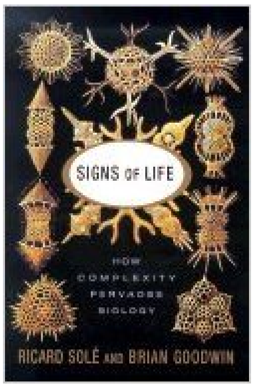
Signs Of Life: How Complexity Pervades Biology



Synopsis

Signs of Life : How Complexity Pervades Biology by Ricard V. Sole and Brian C. Goodwin. Basic Books, Inc.,2000

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Customer Reviews

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One of the best books I’ve uncovered dealing with complexity. Like the inclusion of math and attention to simulation.

Years ago I decided I wanted to grasp, not just know about, complex adaptive systems. This book, along with John Holland’s "Hidden Order" is the one that has helped me the most. It does not give you the answers. Instead it is like having a conversation with a very experienced, intelligent and knowledgeable person who is trying to understand something that I am also interested in. I would give it six stars if I could.

This book is filled with chapter after chapter of ’gee-whiz’ factoids and equations about some interesting attempts to make some scientific sense out of the nature of biological systems. All the appropriate buzzwords: ’complexity’, ’emergence’, ’chaos’, ’neural nets’, ’fractals’, and so on are amply represented. As a compilation or overview of the research efforts into these various areas, this book succeeds reasonably well. For this, it gets three stars.They explain to us in the Preface, "The consistent theme that runs throughout...is the understanding of biological processes in terms of complex dynamics from which emerge characteristic patterns of order. The objective is to show how scientists are thinking in this area and what tools are available for understanding the creative process."But, there is no concluding chapter, no summarization, no binding coherence beyond some vague sense of it all being somehow complex stuff, from ant colonies to brains to stock markets. All the different chapters convey their different messages and that is that. It all sounds important, highly scientific, cutting-edge, and intriguing. Gee, isn't it all amazing?When it is all said and done, however, there is very little about biological systems that is actually explained by all these sexy topics.An unintentional byproduct of this overview - what is most glaringly apparent when the dust settles and the mind clears - is the feebleness of all these efforts in making much of a dent in understanding life to any serious degree. And I think if there is one lesson to be taken away from this book, it ought to be that. For that feebleness makes a deep statement about the cogency of the application of the types of modalities presented to the problem of life, and about the notion of 'emergence' in general as being a computational problem.

Superior

If you've ever been in a traffic jam, chances are, you've also engaged in a coordinated, complicated activity with other drivers - without even knowing about it. They are called traffic density waves. How can that be? How can you engage in large-scale behavior and not know it? It happens because of emergent behavior that results from simple algorithms in our driving. It happens to you, just like it happens to ants, bees, and termites. These simple rules result in unexpected, large-scale order. It's what Sole and Goodwin would call "order for free."Sole and Goodwin begin with one of the best introductory summaries that I've seen of simple chaotic behavior in nonlinear systems. The interesting thing about these systems is the way in which complicated behavior results from repetition and feedback using simple rules.Later descriptions of biological systems carry this theme forward, and constitute some of the most interesting reading in this book. For example, in the chapter on "Ants, Brains, and Chaos," the authors describe a model that simulates the raiding patterns of army ants. Observing these insects from a distance, one might be inclined to wonder at the appearance of a higher purposeful component to the movement of colony. With simulations, however, the authors have argued convincingly that the basic patterns seen in the foraging of army ants result from relatively simple algorithms built into the individual insects. These simple algorithms, at the individual level, result in large-scale behavior that has no obvious causal connection to the algorithms that are their cause.A similar chapter on the human brain helps us see that our own intelligence is most likely the amazing consequence of emergent behavior resulting from the interconnections and interactions of an unimaginable number of connected neurons in our brains. As such, it begins to make sense that what we call "ourselves" is really an emergent property of cells that is as unrelated to individual members as the marauding patterns of army ants is to the simple algorithms operating on the level of individual insects.Yet another fascinating example from the insect world is that of mound-building termites and nest-building wasps like those that infest my barn each year. Again, with computer simulations, the authors illustrate that beautiful wasp-like nests can be created using automata with simple algorithms that belie the complexity of the structures that emerge from groups operating under simple rules.After reading page after page of examples, one begins to get the sense that self organization is a rule of nature. It seems to be everywhere - almost to the degree that we might marvel when it does not appear. This, I believe, is one of the underlying messages in "Signs of Life:" That the order and complexity we perceive is actually the result of simpler algorithms operating in (mostly nonlinear) systems with feedback. That there is a broad range of emergent properties that can, and often do, result from such systems. The authors also argue against the idea that all this complexity is directly encoded in the DNA of organisms. Instead, the organism must encode only the simpler rules of engagement (rules like: 1. smell a pheromone? 2. Dropt the dung) and that the complexity results as "order for fee" through the naturally occurring emergent property of nonlinear systems.Later chapters describe life as being an emergent property on the edge of chaos. There is lots of interesting information here, relating to evolutionary biology and describing how "the edge of chaos" facilitates evolution, and can result in wildly unpredictable outcomes. This part of the book also has worrisome implications for public policy. For example, here in Oregon, the Federal administration recently decided that too much analysis was going into wildlife management. So they decided to cut through the red tape, ignore biologists, and limit water flows in the Lower Klamath drainage basin.Sole and Goodwin would argue that complex biological systems are very complex, and that their response to sudden changes in conditions can result in wildly unpredictable outcomes. We saw that here in Oregon, recently, as tens of thousands of fish died. Biologists attribute this disaster to parasites that live naturally in the water at all times. However, the lowered flows, and higher temperatures, in the river stressed the fish and pushed them closer together. The weakened fish were subsequently more prone to infection, and the closer proximity facilitated dispersal of the disease. The population reached a subsequent threshold where an epidemic ensued, killing a significant fraction of the fish, and putting people's lives in turmoil who depended on the fish for their livelihoods.This example illustrates the problems and dangers inherent in managing wildlife populations. Though bearcats may yearn for simple solutions, these systems are, in fact, complex. Simplistic thinking and/or the inability to engage in sophisticated modeling and prediction can result in disasters. This is as true for the Klamath River basin as it is for Earth's climate and the likely effects of widespread pollution from gases that trap heat near the earth, and raise the global temperature.This is not an easy book to read. It has many equations, and much of the mathematics is non-trivial and involves concepts from nonlinear systems that many readers may not be familiar with. Other terminology in the book is equally aimed at people who already have some exposure to the science at hand. I hope that does not dissuade you. Often, the mathematical details can be skipped (though you will miss some of the most interesting stuff that way). And a dictionary can help you with unfamiliar terminology. Just be aware that this book will demand more of your intellectual capacity than the typical science book that's been written for the arm-chair scientists. But I think it's worth it. I certainly enjoyed it.