Niazi *Complex Adapt Syst Model* (2016) 4:3
DOI 10.1186/s40294-016-0015-x

Complex Adaptive Systems Modeling
a SpringerOpen Journal

BOOK REVIEW Open Access

Introduction to the modeling and analysis of complex systems: a review

Muaz A. Niazi*

*Correspondence:
muaz.niazi@ieee.org
Department of Computer Science, COMSATS Institute of IT, Islamabad, Pakistan

Abstract

Sayama, H *Introduction to the Modeling and Analysis of Complex Systems* Open SUNY textbooks, Milne Library, State University of New York at Geneseo (2015). 485 pages, Print ISBN: 1942341083.

Keywords: Complex systems, Complex networks, Modeling, Simulation

Overview

While there is considerable diversity in the domain of complex adaptive systems modeling research Niazi (2013), there are only a handful of books in the market suitable for use in complexity-related courses. Existing books include Boccara's "Modeling Complex Systems" Boccara (2010) and books with a focus on agent-based modeling including Macal and North's textbook Macal and North (2007) and Railsback and Grimm's book with a focus on the ecological perspective Railsback and Grimm (2011). Mathematically-oriented textbooks include a book by Edward and Hamson, Edwards and Hamson (2007) as well as one by Dym (2004).

Hiroki Sayama's book "Introduction to the Modeling and Simulation of Complex Systems" is therefore a unique and welcome addition to any instructor's collection. What makes it valuable is that it not only presents a state-of-the-art review of the domain but also serves as a gentle guide to learning the sophisticated art of modeling complex systems.

The book is primarily composed of three types of chapters: preliminary chapters followed by logically interspersed modeling and analysis chapters. It has been designed for use both in basic as well as advanced courses spanning 1–2 semesters. Additionally, the book demonstrates the use of PyCX, a freely available Python-based complex systems simulation framework Sayama (2013).

Review

In terms of organization, the book is intuitively sectioned in three parts. The first part starts with an overview of complex systems basics. The second part covers introductory material for formal/mathematical modeling of complex systems. The third part deals with modeling complex systems with a large number of variables.

Part I

The first chapter gives a bird's eye view of the author's perspective of the complex systems universe. In the second chapter, basic concepts and a general overview of modeling and analysis of complex systems are described.

Part II

Chapter 3 describes fundamental concepts of dynamical systems and phase spaces. Chapter 4 describes discrete time modeling using difference equations with a hands-on approach. Chapter 5 focuses on the analysis of discrete-time models including the discovery of equilibrium points, phase space visualization, and cobweb plots among other topics. Chapter 6 describes continuous-time modeling using differential equations with an exercise involving developing a model's equation. Chapter 7 logically follows Chapter 6 with a focus on analyses similar to Chapter 5. Chapter 8 focuses on bifurcations in both continuous and discrete-time models. Chapter 9 introduces Chaos basics including Lyapunov exponent among other topics.

Part III

Chapter 10 introduces interactive simulation of complex systems using PyCX. Chapter 11 and 12 focus on the modeling and analysis of cellular automata models. Continuous field models are described next in Chapter 13 and 14. Chapter 15 introduces network models and is followed by three chapters on the modeling and analysis of dynamic networks both in terms of topology as well as dynamics. The final Chapter 19 introduces agent-based models.

Price

The eVersion of the book is available for free. Additionally, there are two different prices for the color and black and white editions of the printed book—making it an economical buy in either case.

Conclusions

Overall, the book covers a lot of material and is an excellent compendium for modeling and simulation researchers as well as grad students and instructors. After reading it, the only hope is that Dr. Sayama would perhaps also consider adding a second volume or a few chapters in the next edition to discuss more topics specific to agents and agent-based modeling.

Competing interests
The author declare that they have no competing interests.

Received: 17 December 2015 Accepted: 8 January 2016
Published online: 03 February 2016

References

Boccara N (2010) Modeling complex systems. Springer, Heidelberg
Dym C (2004) Principles of mathematical modeling. Academic press, New York
Edwards D, Hamson M (2007) Guide to mathematical modelling. Industrial Press, South Norwalk
Macal CM, North M (2007) Managing business complexity: discovering strategic solutions with agent-based modeling and simulation. Oxford Scholarship Online

Niazi MA (2013) Complex adaptive systems modeling: a multidisciplinary roadmap. Complex Adaptive Syst Model 1(1):1–14
Railsback SF, Grimm V (2011) Agent-based and individual-based modeling: a practical introduction. Princeton University Press, Princeton
Sayama H (2013) Pycx: a python-based simulation code repository for complex systems education. Complex Adaptive Syst Model 1(1):1–10