Grimm, Volker; **Railsback, Steven F.**

Individual-based modeling and ecology. (English) Zbl 1085.92043

Princeton Series in Theoretical and Computational Biology. Princeton, NJ: Princeton University Press (ISBN 0-691-09666-X/pbk). xvi, 428 p. (2005).

The authors' main goal in this book is to establish an effective and coherent framework for the use of individual-based models (IBM) in theoretical and applied ecology. They start from the fundamental fact that an understanding of the relationships between the adaptive traits of individual organisms and patterns at the population, community and ecosystem levels of organization is fundamental to ecology. They adopt four criteria that define an IBM: life cycles of individuals are reflected in the model, resources utilized by individuals are explicitly represented, integer numbers are used to represent population size, and individual traits vary with chronological age. While IBMs are firmly established in ecology today, the authors recognize that the vision of a significant paradigm shift in ecological modeling that was held by early proponents of IBMs has not come to pass. It has proved difficult to construct IBMs in ecology, to learn something from them, and to produce results of general theoretical interest. However, the authors are of the opinion that the potential of IBMs remains high and is for, the most part, unfulfilled.

This book represents their attempt to deal with the problems that have limited the success of IBMs. The authors argue that this effort is eminently worthwhile because an ecology based on IBMs (an IBE) can address many questions that traditional ecological approaches cannot, questions such as: how do system level patterns emerge from individual behavior, what individual traits and mechanisms determine ecosystem level distributions and abundances, and how can mechanistically realistic models be developed and tested for use by applied ecologists. "Traditional" ecology, being based on analytic models that operate on high scales of aggregation, is ill-suited to address such questions. An IBE differs in its use of models that contain many kinds of biological and physical information, the use of computer simulations instead of calculus, the procedures by means of which models are calibrated and validated, and the ways in which the models, research, and results are communicated.

The book has four parts. Part I (Modeling) contains three chapters that address, in detail, the modeling methodology used throughout the book. The three chapters of Part II (Individual-Based Ecology) are devoted to describing the use of IBMs in ecological studies and defining what a theory of IBE is and what issues such a theory addresses. A large number of specific examples are provided. Part III (The Engine Room) has four chapters that deal with how to carry out an IBM project: formulating the details, developing software, conducting analysis, and advice on communicating the results. Part IV (Conclusions and Outlook) summarizes the authors' philosophy concerning the use of IBMs, their benefits and potential in constructing an IBE and how their approach relates to the general problem of complexity in science.

For anyone who wants to know more about and possibly incorporate IBMs in his own research, this book provides plenty of advice and guidance on how to formulate, analyze, and use such models. If IBMs do ultimately reach the potential envisioned by the authors, their seminal book will have done much to contribute to that success.

Reviewer: Jim M. Cushing (Tucson)

MSC:

92D40 Ecology
91B76 Environmental economics (natural resource models, harvesting, pollution, etc.)
92-02 Research exposition (monographs, survey articles) pertaining to biology
92D25 Population dynamics (general)

Keywords:

individual-based models; ecology