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Ledder, Glenn

Mathematics for the life sciences. Calculus, modeling, probability, and dynamical systems.

Springer Undergraduate Texts in Mathematics and Technology. New York, NY: Springer (ISBN 978-1-4614-7275-9/hbk; 978-1-4614-7276-6/ebook). xx, 431 p. (2013).

There are several good reasons for the reviewer to warmly recommend this text. First of all, because of the author's idea that "the basic premise of this book is that there is a lot of mathematics that is useful in some life science context and can be understood by people with a limited background in calculus, provided it is presented at an appropriate level and connected to life science ideas." Secondly, because we all agree that there is a need to close the gap between several outstanding texts in mathematical biology at the advanced and beginning graduate level and the knowledge of mathematics most biology students have – the book has been designed with this intention in mind. Thirdly, because reducing the prerequisites for a reader to a bare minimum of the first calculus course, Professor Ledder skillfully blends mathematical ideas and biological context in applications and presents material at the level of rigor appropriate for biology students. "It is my aim to provide a balanced approach to mathematical precision. Conclusions should be backed by solid evidence and methods should be supported by an understanding of why they work, but that evidence and methods need not have the rigor of a mathematical proof." Arguing about technology that might be used for teaching, the author motivates his choice as follows. "Rather than trying to find the very best tool for each individual task, my preference is to work with one tool that is reasonably good for any task (save symbolic computation) and is readily available. By these criteria, my choice is R, which runs smoothly in any standard operating system and is popular among biologists." A collection of R scripts for various algorithms presented in the text is available at the publisher's link. Professor Ledder emphasizes that "these scripts are designed to be simple rather than robust; that is, compared to professionally written programs, they are easier to understand but less efficient and they lack error detection machinery. Their presence allows students to replace the difficulty of having to learn R from scratch with the much lesser difficulty of having to be able to read an R program and make minor modifications." The material in the book is organized into three parts, the last two could easily have been reversed. Two chapters in the preparatory Part I provide a brief summary of calculus with a special attention only to "those aspects of calculus that provide the necessary background for the modeling, probability, and dynamical systems that make up the rest of the book" and a chapter on mathematical modeling featuring the role mathematics plays in biology, basic concepts of modeling, and a wealth of material on empirical and mechanistic modeling. Chapters 3 and 4 constitute Part II of the book where the fundamental ideas and some applications of probability are discussed. The distinctive feature of this part is best explained by the author himself. "My colleagues in biology helped me appreciate that the central topic of probability for scientists is that of probability distribution, and this topic is best approached informally by thinking of a probability distribution as a mathematical model of a data set. My aim has been to get to probability distributions as quickly as possible while saving other topics, such as conditional probability, for later." The final three chapters in Part III introduce the basic ideas of the theory of dynamical systems, starting with the dynamics of a single species which is used to demonstrate main techniques of mathematical analysis (cobweb analysis, phase line analysis, linearized stability). Then the exposition proceeds to the study of multivariable discrete systems and concludes with the discussion of multivariable continuous dynamical systems. Additional topics in discrete dynamical systems are addressed in Appendix A, whereas brief information on the definite integral via Riemann sums and a Runge-Kutta method of solution for differential equations can be found in Appendices B and C. The exposition is very clear and detailed with a large number of carefully selected examples and exercises based on the material familiar to biologists. An excellent choice for the lecturer interested in designing a 2-course sequence of 4-credit courses covering almost the entire book, a 2-course sequence of 3-credit calculus-for-biology courses for students with no calculus background, or a 3-credit calculus-for-biology course with selected material.

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