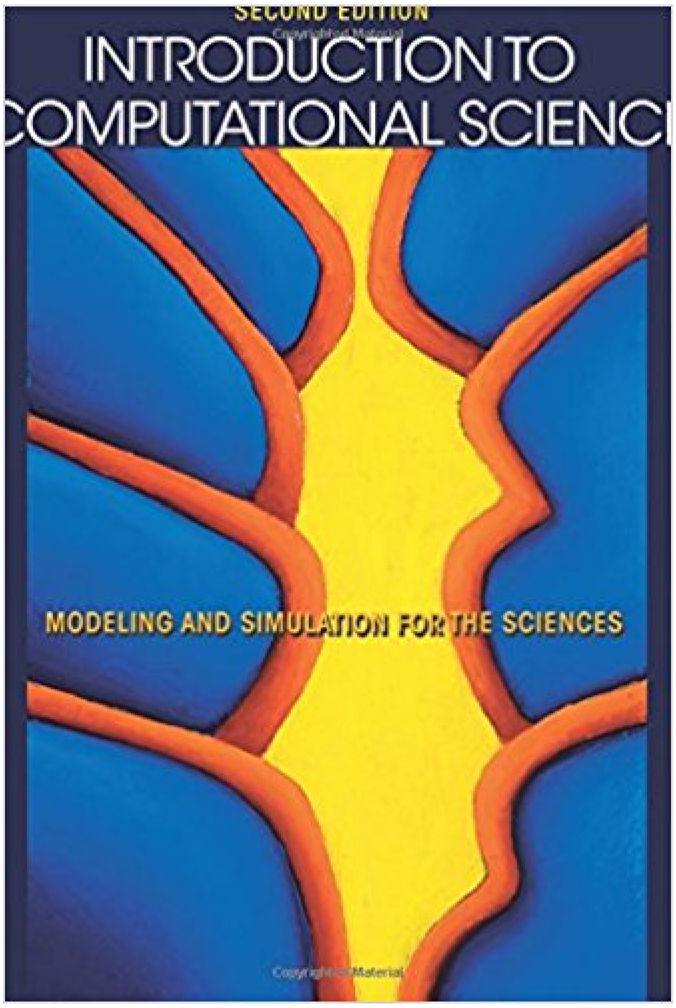
Introduction To Computational Science: Modeling And Simulation For The Sciences, Second Edition



Synopsis

Computational science is an exciting new field at the intersection of the sciences, computer science, and mathematics because much scientific investigation now involves computing as well as theory and experiment. This textbook provides students with a versatile and accessible introduction to the subject. It assumes only a background in high school algebra, enables instructors to follow tailored pathways through the material, and is the only textbook of its kind designed specifically for an introductory course in the computational science and engineering curriculum. While the text itself is generic, an accompanying website offers tutorials and files in a variety of software packages.This fully updated and expanded edition features two new chapters on agent-based simulations and modeling with matrices, ten new project modules, and an additional module on diffusion. Besides increased treatment of high-performance computing and its applications, the book also includes additional quick review questions with answers, exercises, and individual and team projects.The only introductory textbook of its kindÃ¢â ¬â ¢now fully updated and expandedFeatures two new chapters on agent-based simulations and modeling with matricesIncreased coverage of high-performance computing and its applicationsIncludes additional modules, review questions, exercises, and projectsAn online instructor's manual with exercise answers, selected project solutions, and a test bank and solutions (available only to professors)An online illustration package is available to professors

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Customer Reviews

"The first edition of this book had received very positive feedback and was warmly welcomed by the mathematical community. It is very good news for all us is that the second revised edition is even better!"--Svitlana P. Rogovchenko, Zentralblatt MATHPraise for the previous edition: "The heart of Introduction to Computational Science is a collection of modules. Each module is either a discussion of a general computational issue or an investigation of an application. . . . [This book] has been carefully and thoughtfully written with students clearly in mind."--William J. Satzer, MAA ReviewsPraise for the previous edition: "Introduction to Computational Science is useful for students and others who want to obtain some of the basic skills of the field. Its impressive collection of projects allows readers to quickly enjoy the power of modern computing as an essential tool in building scientific understanding."--Wouter van Joolingen, Physics TodayPraise for the previous edition: "A masterpiece. I know of nothing comparable. I give it five stars."--James M. Cargal, UMAP JournalPraise for the previous edition: "This is an important book with a wonderful collection of examples, models, and references."--Robert M. Panoff, Shodor Education FoundationPraise for the previous edition: "This is a very good introduction to the field of computational science."--Peter Turner, Clarkson University"Despite its substantial weight, the book is extremely user friendly. . . . There are many different courses that one could build with this book as foundation, and it is an indispensible resource for anyone seeking to bring modeling projects into their classes."--David M. Bressoud, UMAP Journal

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Using it in an introductory modeling & sim course. It frequently asks you to do things in the ’projects’ and exercises without giving you any clue how to do so. I can tell that if I knew more math it would be pretty clear and simple, but if you haven’t had a higher level math class lately (or didn’t have the right ones) the book is an exercise in frustration as it will give you partial instructions to a simple example, and then give you little to no instruction for a more complicated one that requires extra steps. Maybe it’s good if you already know what you’re doing (in which case, why do you need this book?) but as a beginner, it’s almost completely worthless.

I enjoyed reading this book very much.I found the book very useful in its conceptualization of simulation as a new form of synthesis for acquiring knowledge and helping human being make decisions. Simulation is a form of communication in that empirically-based models could be used to view the on-going processes that are cognitively beyond the capacity of human mind to untangle.Furthermore, I found it admirable that the authors had instructed the readers in the art of model building using widely available simulation tools or even tools such as MS Excel that are not built specifically for the purpose of simulations.I especially liked the tutorials with their wide selection of interesting material.Regrettably, the subject matter of the book - simulation & (dynamic model building) - does not fit well within the traditional physics curriculum: Mechanics, Electromagnetism, and Quantum Mechanics. Numerical methods, including simulations, are not emphasized in such courses and normally one spends much of one's time studying well-known and solvable (in closed, analytical form) problems.That does not mean that there is no room in physics for modeling and simulation: fractals, galaxy formation, dynamics of globular clusters, etc. are all areas that we are dependent on our numerical models and their fitness to observed phenomena to understand the processes of Nature. However, these are usually advanced topics not covered in undergraduate curricula.And then the physicists tend to want to build their own tools rather that use COTS packages.I think it is difficult to find a home in traditional university departments for a course on simulation based on this book. The fundamental reason, in my opinion, is that the personal computer as a scientific instrument is not valued or appreciated. And from that follows the lack of interest in simulations as venues for gaining scientific knowledge in Physics, in Chemistry & Biology. Conceivably a course in simulations might be of interest to engineers but then we would be leaving all those "soft"-science majors such as Ecology or Public Health behind. And those soft-science students are among some the people who could benefit the most from this book.For example, the geneproteinenzyme interactions, with their feedback loops and multiple pathways, are so complex that no human mind could expect to grasp all that goes on inside a cell. So Module 6.3 covering enzyme dynamics is absolutely on the right track from a scientific perspective; taking simulation out of the "hard" science world and into biology. Only through simulations and modeling are we going to develop a synthetic understanding of the cell in all its complexity.I do not know if you have seen the book, "Historical Dynamics" by Peter Turchin in which he presents and discusses mathematical models of the evolution of agrarian states on the Eurasian land mass. His models are informed by empirical data collected from historical sources and do capture many aspects of historical reality. There is clearly a very important paradigm here at work but which is not as enunciated as I believe it should be; namely that simulations extend our scientific evidentiary-based knowledge into hitherto for dark realms of empirical experience.Yet, Turchin did not use a simulation tool; he rolled his own and wrote much of his code in APL (A Programming Language) which is quite obscure. So readers must redo the models themselves. And his book is not about simulations, it is about what simulations tell us about history. I think that there are many fields of study in which the students could benefit from parts of this book; history, sociology, ecology, and natural resources comes to mind. There the exposition must be based heavily on using Commercial Off-the-Shelf (COTS) packages to teach the students how to build useful models.So, for students in "soft" departments, the material in modules 5.2, 5.3, 5.4 could be skipped. In fact, even for students of physics and engineering, the understanding of the basis of the numerical simulations is not as important as learning how to build a system and observing how it behaves. On the other hand, the module 2, in my opinion, is important for all students to understand and to master so that they may interpret the results of their simulations correctly.In my own case, I would love to be able to use a COTS package in which I could put galaxies - using a visual palette tool - on a 3-dimensional grid and observe their evolution in time as I changed the metric of space-time and/or the equation of state of the matter field.Or consider the equations of stellar evolution, one would love to be able to run them again and again by changing parameters of these models knowing that the fundamental equations and their integration were worked out 70 years ago. As it is today, there are no such user-friendly generic approaches available to students or researchers, all such things must be painfully hand-crafted almost from scratch, barring some software libraries.On a few occasions that I imagined writing such a book myself, I realized how difficult it was to do justice to the breadth and depth of the field of simulations from its hard-core physical scieces and engineering to ecology and wild-life management in a single book. While I might quibble with the inclusion of this or that topic or technique, I really cannot come up with a better design. There is an enormous amount of material here that may or may not be of interest to all audiences but there is a lot of material that is of interest to special audiences with focus on this or that scientific field.The authors, if I understand them correctly, are positing that simulations (Computational Sciences) as a new way of knowledge discovery. In this they are right, in my opinion and are in the company of such luminaries as Dr. Steven Wolfram of Mathematic fame. But the problem is that "Introduction to Simulations" used to be taught in Industrial Engineering departments and then moved to places like the RAND Corporation and then the Pentagon. It is not viewed as a subject worthy of study in its own right (although such simulations as Halo or the World of War Craft sell millions of copies and make a few people quite wealthy).Which brings me to another topic related to simulations and to this book; namely computer games. Computer games are also simulations but with the caveat that they do not follow the Laws of Physics, Chemistry, and Biology and therefore are on somewhat of a tangent to "scientific" simulations such as those covered in this book. Gamers perform simulations, cosmologists do simulations, climatologists do simulations, agronomists do simulations, and many others but there is not set curriculum, no defined or unified approach and indeed no place to go to get an introduction to the art and science of simulation in a typical undergraduate college. This book is an attempt at just that.I think non-science majors in Liberal Arts colleges could benefit also from a simulation course based on this book. Some colleges have a unified natural science department without the traditional divisions among Physics, Chemistry, Mathematics, and Biology. In such an environment, a course based on this book may offer the non-science majors - a la Dr. Turchin's approach - the prospect of gaining confidence in building quantitative models of Reality and making inferences about the world on basis of such models.This is a good book and a path-breaking book and I hope it finds the traction that it so righty deserves.

This is a great book for the college bound. Very interesting and easy to read.

This book has the potential to be great but not as is. It is kind of a compilation of other authors work right now. Also, the authors leave too much to the reader. Basically the book needs to be completed. The tutorials need to have FULL solutions. Also the works need to be original not just take a bunch of stuff from my differential equations book and others and slap it in there and site it...But, I would definitely recommend the authors devote everything to this and not to stop because it could become the future textbook for computational science

If you have a solid background in math (calculus, differential equations), physics, or computer science, you will probably find this book to be very elementary, and you will likely hate the approach it uses (visual methods for understanding differential equations, annoying pseudo code, etc). It only touches on the subjects it broaches, with terribly simple and poorly articulated exercises, and "projects" that in general should be exercises (thus there aren't really "projects"). This book was used for a graduate level course I took, and in my opinion is barely suitable for an undergraduate course.

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