

Preface

It is no exaggeration to say that computational mathematics is the foundation of modern scientific computing. Traditional sciences consist of two major paradigms: theory and experiment. With the increase of computing speed, there emerges a third paradigm: computer simulations. Numerical algorithms are the very essence of any computer simulations, and computational mathematics is just the science of developing and analyzing numerical algorithms.

The topics of computational mathematics are broad and the related literature is vast. It is often a daunting task for beginners to find the right book(s) and to learn the right algorithms that are widely used in computational mathematics. Even for lecturers and educators, it is no trivial task to decide what algorithms to teach and to provide a balanced coverage of a wide range of topics, because there are so many algorithms to choose from.

Loosely speaking, computational mathematics should include at least the following areas: basic numerical algorithms (such as root-find algorithms and numerical integration), computational linear algebra, numerical solutions of partial differential equations, mathematical optimization or programming, discrete and statistical modelling, and modern simulation tools such as finite element analysis.

Therefore, this book strives to provide a balanced coverage of efficient algorithms commonly used in computational mathematics and modern scientific computing. It covers all the major topics from mathematical foundations to routinely used finite element analysis, from conventional algorithms (such as numerical integration) to modern metaheuristic methods. We will also provide dozens of worked examples to demonstrate how these algorithms work.

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