

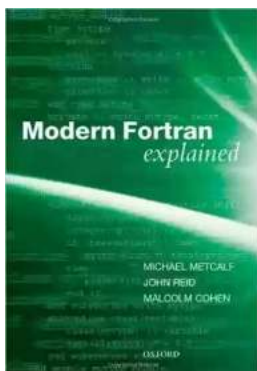
Modern Fortran Explained: Numerical Mathematics And Scientific Computation

Fortran, short for Formula Translation, is a high-level programming language primarily used in scientific and numerical computing. It has a long history and has been continuously evolving to meet the needs of modern computational challenges. In this article, we will explore how Modern Fortran is utilized in numerical mathematics and scientific computation.

What is Modern Fortran?

Modern Fortran is an extension of the original Fortran language with added features to enhance its capabilities in modern computing environments. It was first standardized in 1997 as Fortran 90, introducing several new constructs and improvements over its predecessor, Fortran 77.

Since then, the language has undergone further enhancements with subsequent standards like Fortran 95, Fortran 2003, Fortran 2008, and the latest version, Fortran 2018. These modern standards have contributed to making Fortran a powerful tool for numerical mathematics and scientific computation.



Modern Fortran Explained (Numerical Mathematics and Scientific Computation)

by Michael Metcalf(4th Edition, Kindle Edition)

★★★★☆ 4.1 out of 5

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Screen Reader: Supported

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Why use Modern Fortran for Numerical Mathematics?

Modern Fortran provides a range of features that make it particularly well-suited for numerical mathematics and scientific computation. Some of the reasons to choose Fortran in this domain include:

1. **Efficiency:** Fortran's design focuses on performance, and compilers often produce highly optimized machine code. This makes it ideal for computationally intensive tasks.
2. **Compatibility with legacy code:** Many scientific and numerical codes were originally written in Fortran. Modern Fortran can seamlessly integrate with existing Fortran 77 or Fortran 90 codebases, allowing for easy maintenance and extension.
3. **Array manipulation:** Fortran offers powerful built-in support for multidimensional arrays, making it easier to handle mathematical operations on matrices and vectors.
4. **Extensive numerical libraries:** Fortran offers a wide range of numerical libraries like BLAS and LAPACK, which provide efficient and reliable implementations of various mathematical algorithms.
5. **Parallel computing capabilities:** Modern Fortran includes features like coarray parallelism and OpenMP directives, allowing for efficient utilization of multi-core processors and distributed memory systems.

Numerical Mathematics with Modern Fortran

Modern Fortran offers various features and libraries that greatly simplify the implementation of numerical mathematics algorithms. Let's look at some key areas where Fortran excels:

Numerical Integration

Fortran provides efficient tools for numerical integration, allowing us to approximate definite integrals of functions. Libraries such as QUADPACK provide different methods like adaptive quadrature and Gaussian quadrature to compute integrals accurately.

Numerical Optimization

Optimization problems often arise in numerical mathematics, and Fortran offers robust libraries like NLOPT and NLOptFortran for solving these problems. These libraries implement various optimization algorithms, including gradient-based and derivative-free methods.

Linear Algebra

Linear algebra is a fundamental topic in numerical mathematics, and Fortran excels in this domain. Libraries like LAPACK offer efficient routines for solving systems of linear equations, performing eigenvalue computations, and performing matrix factorizations.

Ordinary Differential Equations (ODEs)

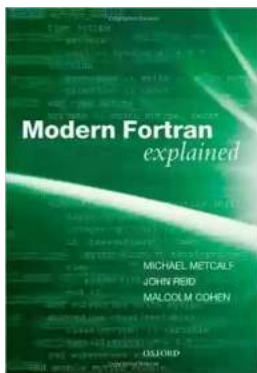
Fortran provides specialized libraries like ODEPACK and LSODA for solving ordinary differential equations. These libraries offer a variety of solvers suitable for different types of ODEs, ensuring accurate and efficient solutions to time-dependent problems.

Partial Differential Equations (PDEs)

Modern Fortran includes libraries like PETSc (Portable, Extensible Toolkit for Scientific Computation) and FEniCS for solving partial differential equations. These libraries provide advanced tools for discretization, linear algebra, and iterative methods, enabling the simulation of complex physical phenomena.

Modern Fortran has witnessed significant advancements over the years, making it a popular choice for numerical mathematics and scientific computation. With its efficiency, compatibility with legacy code, powerful array manipulation capabilities, extensive numerical libraries, and parallel computing features, Fortran continues to play a crucial role in solving computationally demanding problems in various scientific disciplines.

If you're interested in numerical mathematics and scientific computation, exploring Modern Fortran can prove to be a rewarding endeavor. Its rich ecosystem of libraries and robust language features can aid in the development of efficient and accurate numerical algorithms. So, why not harness the power of Modern Fortran for your next computational project?



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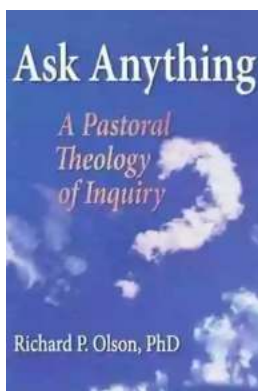
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Fortran remains one of the principal programming languages used in high-performance scientific, numerical, and engineering computing. A series of significant revisions to the standard versions of the language have progressively enhanced its capabilities and the latest standard, Fortran 2008, includes many modern features, such as object orientation, coarrays for parallel programming, interoperability with C and various other enhancements.

Modern Fortran Explained expands on its predecessor, Fortran 95/2003 Explained. The opening chapters contain a complete description of Fortran 95, extended by Fortran 2003 allocatable array features. Coverage of the other additional features of Fortran 2003 follows, before new chapters on coarrays and the many other enhancements of Fortran 2008. The distinction between the three language levels is maintained throughout, allowing readers to understand and amend legacy code as well as the new features.

Authored by three experts in the field, two of whom have actively contributed to Fortran 2008, this is a complete and authoritative description of Fortran in its modern form. It is intended for new and existing users of the language and for all those involved in scientific and numerical computing. It is suitable as a textbook for teaching and, with its extensive Appendices and an Index, as a handy reference for practitioners.



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