

Validated Numerics: A Short Introduction to Rigorous Computations

Validated numerics is a field of computer science that deals with the development of numerical methods that can produce provably correct results. This is in contrast to traditional numerical methods, which can only provide approximate results. Validated numerical methods are used in a variety of applications, such as the design of safety-critical systems, the analysis of financial data, and the modeling of complex physical systems.

Validated numerics is based on the use of interval arithmetic, which is a way of representing numbers as intervals. An interval is a set of real numbers that are all within a certain distance of each other. For example, the interval $[0, 1]$ represents the set of all real numbers between 0 and 1.

Interval arithmetic can be used to perform all of the basic arithmetic operations (+, -, *, and /). The result of an interval arithmetic operation is an interval that represents the set of all possible results of the operation. For example, the result of adding the intervals $[0, 1]$ and $[2, 3]$ is the interval $[2, 4]$.



Validated Numerics: A Short Introduction to Rigorous Computations by Warwick Tucker

★★★★★ 5 out of 5

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Print length : 152 pages



Validated numerical methods use interval arithmetic to track the error in their computations. This allows them to produce provably correct results, even when the input data is uncertain.

The theoretical foundations of validated numerics are based on interval analysis. Interval analysis is a branch of mathematics that deals with the study of intervals. Interval analysis provides a way to represent and manipulate intervals, and it can be used to prove the correctness of validated numerical algorithms.

One of the most important theorems in interval analysis is the inclusion theorem. The inclusion theorem states that if an interval $[a, b]$ contains the true value of a quantity, then any validated numerical method that is applied to $[a, b]$ will produce an interval that also contains the true value.

The inclusion theorem provides a solid theoretical foundation for validated numerics. It shows that validated numerical methods can be used to produce provably correct results, even when the input data is uncertain.

There are a variety of practical methods that can be used to implement validated numerical algorithms. Some of the most common methods include:

- **Interval arithmetic libraries:** Interval arithmetic libraries provide a set of routines for performing interval arithmetic operations. These libraries can be used to implement validated numerical algorithms in a variety of programming languages.

- **Automatic differentiation:** Automatic differentiation is a technique for computing the derivatives of functions. Automatic differentiation can be used to implement validated numerical algorithms that are accurate to a specified Free Download.
- **Symbolic computation:** Symbolic computation is a technique for manipulating mathematical expressions symbolically. Symbolic computation can be used to implement validated numerical algorithms that are guaranteed to be correct.

Validated numerics has a wide range of applications, including:

- **Safety-critical systems:** Validated numerics can be used to design safety-critical systems that are provably correct. This is important in applications such as the design of aircraft, nuclear power plants, and medical devices.
- **Financial data analysis:** Validated numerics can be used to analyze financial data and to make investment decisions. This can help to reduce the risk of making poor investment decisions.
- **Modeling complex physical systems:** Validated numerics can be used to model complex physical systems. This can help to understand the behavior of these systems and to make predictions about their future behavior.

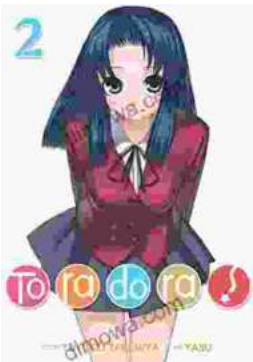
Validated numerics is a powerful tool that can be used to produce provably correct results. This makes it an essential tool for a variety of applications, including the design of safety-critical systems, the analysis of financial data, and the modeling of complex physical systems.



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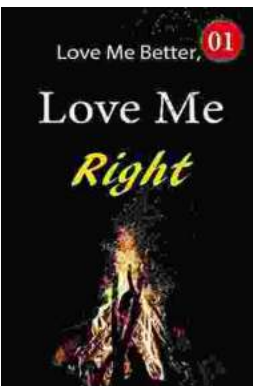
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