

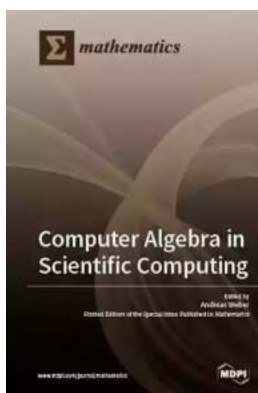
# Computer Algebra in Scientific Computing: Solving Complex Equations Faster

Are you tired of spending hours trying to solve complex equations manually? Look no further – computer algebra systems are here to revolutionize scientific computing, making tedious calculations a thing of the past.

Computer algebra, also known as symbolic computation, is the branch of mathematics and computer science that deals with solving mathematical problems using algorithms implemented on computers. It encompasses a wide range of techniques and software tools specifically designed to handle symbolic calculations.

## The Power of Computer Algebra Systems

Computer algebra systems (CAS) are software tools that allow scientists, engineers, and mathematicians to perform intricate mathematical operations with ease. By automating the symbolic manipulation of mathematical expressions, CAS significantly speeds up the process of solving complex equations.



## Computer Algebra in Scientific Computing: 21st International Workshop, CASC 2019, Moscow, Russia, August 26–30, 2019, Proceedings (Lecture Notes in Computer Science Book 11661)

by S.D. Metcalfe(1st ed. 2019 Edition, Kindle Edition)

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These systems are built upon a set of algorithms and rules that enable them to perform fundamental mathematical operations such as simplification, factorization, expansion, differentiation, integration, and solving polynomial equations.

One of the key advantages of using computer algebra systems is their ability to handle symbolic expressions. Unlike numerical computing, which only deals with approximate computations, computer algebra systems work with symbolic expressions, manipulating them as algebraic entities rather than numerical approximations.

This symbolic manipulation allows scientists to gain a deeper understanding of mathematical problems, as it provides insights into the underlying structure and relationships within the equations. With CAS, scientists can explore mathematical concepts beyond the scope of traditional pen-and-paper calculations.

## **Applications of Computer Algebra in Scientific Computing**

The applications of computer algebra systems in scientific computing are vast and cross multiple disciplines. Let's explore some of the key domains where computer algebra is making a significant impact:

### **Physics and Engineering**

In physics and engineering, computer algebra systems are crucial for solving complex equations derived from fundamental principles and physical laws. These systems enable researchers and engineers to model, simulate, and analyze physical phenomena with greater accuracy and efficiency. Whether it's solving differential equations, deriving fundamental equations, or optimizing parameters, computer algebra has become an indispensable tool in these fields.

## **Cryptanalysis**

Computer algebra systems play a crucial role in cryptanalysis, the science of deciphering coded messages. Cryptographers use algebraic techniques to break encryption schemes, involving solving systems of equations to uncover the secret keys. With the help of computer algebra systems, cryptanalysts can automate and accelerate the process of breaking cryptographic codes, ensuring the security of modern communication systems.

## **Number Theory**

Number theory deals with the properties and relationships of numbers, and computer algebra systems have proven to be invaluable in this field. From primality testing to factoring large numbers, computer algebra systems have advanced our understanding of number theory. Additionally, these systems help researchers explore mathematical patterns and conjectures that guide further investigations.

## **Symbolic Computation in Mathematics Education**

Computer algebra systems have also made significant contributions to mathematics education. These tools provide students with a hands-on experience in exploring mathematical concepts and solving complex equations. By automating the tedious calculations, computer algebra systems allow students to

focus on the underlying principles and gain a deeper understanding of mathematical concepts.

## **The Future of Computer Algebra Systems**

Computer algebra systems are continuously evolving, driven by advancements in computational power and algorithms. As technology progresses, these systems are becoming more efficient, capable of handling larger and more intricate mathematical problems.

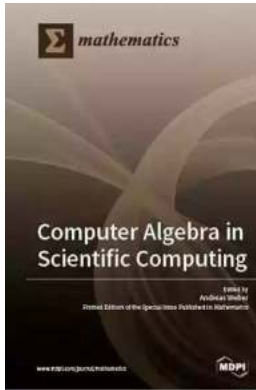
Future developments in computer algebra systems will likely focus on improving the integration with other software tools and expanding the capabilities of symbolic computation. Furthermore, the advent of artificial intelligence and machine learning may introduce new paradigms in computer algebra, allowing systems to learn from vast mathematical knowledge bases and propose innovative solutions.

, computer algebra systems have revolutionized scientific computing by providing powerful tools for solving complex equations faster. From physics and engineering to cryptanalysis and number theory, computer algebra is making significant contributions across various domains. As technology progresses, we can expect further advancements in computer algebra systems, empowering scientists, engineers, and mathematicians to push the boundaries of knowledge and tackle increasingly complex mathematical problems.

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This book constitutes the refereed proceedings of the 21st International Workshop on Computer Algebra in Scientific Computing, CASC 2019, held in Moscow, Russia, in August 2019.

The 28 full papers presented together with 2 invited talks were carefully reviewed and selected from 44 submissions. They deal with cutting-edge research in all major disciplines of computer algebra. The papers cover topics such as polynomial algebra, symbolic and symbolic-numerical computation, applications of symbolic computation for investigating and solving ordinary differential equations, applications of CASs in the investigation and solution of celestial mechanics problems, and in mechanics, physics, and robotics.



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