

# From Mathematics To Generic Programming

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*From Mathematics To Generic Programming*

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## SUSAN VEGA

**A Pragmatic Introduction to the Coq Proof Assistant** Simon and Schuster

In this substantive yet accessible book, pioneering software designer Alexander Stepanov and his colleague Daniel Rose illuminate the principles of generic programming and the mathematical concept of abstraction on which it is based, helping you write code that is both simpler and more powerful. If you're a reasonably proficient programmer who can think logically, you have all the background you'll need. Stepanov and Rose introduce the relevant abstract algebra and number theory with exceptional clarity. They carefully explain the problems mathematicians first needed to solve, and then show how these mathematical solutions translate to generic programming and the creation of more effective and elegant code. To demonstrate the crucial role these mathematical principles play in many modern applications, the authors show how to use these results and generalized algorithms to implement a real-world public-key cryptosystem. As you read this book, you'll master the thought processes necessary for effective programming and learn how to generalize narrowly conceived algorithms to widen their usefulness without losing efficiency. You'll also gain deep insight into the value of mathematics to programming—insight that will prove invaluable no matter what programming languages and paradigms you use. You will learn about How to generalize a four thousand-year-old algorithm, demonstrating indispensable lessons about clarity and efficiency Ancient paradoxes, beautiful theorems, and the productive tension between continuous and discrete A simple algorithm for finding greatest common divisor (GCD) and modern abstractions that build on it Powerful mathematical approaches to abstraction How abstract algebra provides the idea at the heart of generic programming Axioms, proofs, theories, and models: using mathematical techniques to organize knowledge about your algorithms and data structures Surprising subtleties of simple programming tasks and what you can learn from them How practical implementations can exploit theoretical knowledge

**A Gentle Introduction to Numerical Simulations with MATLAB/Octave** MIT Press

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory and its particular branches, such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering

**A Programmer's Introduction to Mathematics** Cambridge University Press

Essential Mathematics for Games and Interactive Applications, 2nd edition presents the core mathematics necessary for sophisticated 3D graphics and interactive physical simulations. The book begins with linear algebra and matrix multiplication and expands on this foundation to cover such topics as color and lighting, interpolation, animation and basic game physics. Essential Mathematics focuses on the issues of 3D game development important to programmers and includes optimization guidance throughout. The new edition Windows code will now use Visual Studio.NET. There will also be DirectX support provided, along with OpenGL - due to its cross-platform nature. Programmers will find more concrete examples included in this edition, as well as additional information on tuning, optimization and robustness. The book has a companion CD-ROM with exercises and a test bank for the academic secondary market, and for main market: code examples built around a shared code base, including a math library covering all the topics presented in the book, a core vector/matrix math engine, and libraries to support basic 3D rendering and interaction.

**An Introduction to Distributed Algorithms** Cambridge University Press

This book presents computer programming as a key method for solving mathematical problems. There are two versions of the book, one for MATLAB and one for Python. The book was inspired by the Springer book TCSE 6: A Primer on Scientific Programming with Python (by Langtangen), but the style is more accessible and concise, in keeping with the needs of engineering students. The book outlines the shortest possible path from no previous experience with programming to a set of skills that allows the students to write simple programs for solving common mathematical problems with numerical methods in engineering and science courses. The emphasis is on generic algorithms, clean design of programs, use of functions, and automatic tests for verification.

**Using the C++ Standard Template Libraries** Springer Science & Business Media

Computing is quickly making much of geometry intriguing not only for philosophers and mathematicians, but also for scientists and engineers. What is the core set of topics that a practitioner needs to study before embarking on the design and implementation of a geometric system in a specialized discipline? This book attempts to find the answer. Every programmer tackling a geometric computing problem encounters design decisions that need to be solved. This book reviews the geometric theory then applies it in an attempt to find that elusive "right" design.

**Second Edition** Springer

If you're just learning how to program, Julia is an excellent JIT-compiled, dynamically typed language with a clean syntax. This hands-on guide uses Julia 1.0 to walk you through programming one step at a time, beginning with basic programming concepts before moving on to more advanced capabilities, such as creating new types and multiple dispatch. Designed from the beginning for high performance, Julia is a general-purpose language ideal for not only numerical analysis and computational science but also web programming and scripting. Through exercises in each chapter, you'll try out programming concepts as you learn them. Think Julia is perfect for students at the high school or college level as well as self-learners and professionals who need to learn programming basics. Start with the basics, including language syntax and semantics Get a clear definition of each programming concept Learn about values, variables, statements, functions, and data structures in a logical progression Discover how to work with files and databases Understand types, methods, and multiple dispatch Use debugging techniques to fix syntax, runtime, and semantic errors Explore

interface design and data structures through case studies

**Think Julia** CRC Press

A handbook to the Coq software for writing and checking mathematical proofs, with a practical engineering focus. The technology of mechanized program verification can play a supporting role in many kinds of research projects in computer science, and related tools for formal proof-checking are seeing increasing adoption in mathematics and engineering. This book provides an introduction to the Coq software for writing and checking mathematical proofs. It takes a practical engineering focus throughout, emphasizing techniques that will help users to build, understand, and maintain large Coq developments and minimize the cost of code change over time. Two topics, rarely discussed elsewhere, are covered in detail: effective dependently typed programming (making productive use of a feature at the heart of the Coq system) and construction of domain-specific proof tactics. Almost every subject covered is also relevant to interactive computer theorem proving in general, not just program verification, demonstrated through examples of verified programs applied in many different sorts of formalizations. The book develops a unique automated proof style and applies it throughout; even experienced Coq users may benefit from reading about basic Coq concepts from this novel perspective. The book also offers a library of tactics, or programs that find proofs, designed for use with examples in the book. Readers will acquire the necessary skills to reimplement these tactics in other settings by the end of the book. All of the code appearing in the book is freely available online.

**The Audio Programming Book** Addison-Wesley Professional

Introduces programmers to the generic programming paradigm and to the C++ Standard Template Library and its use as an extensible framework for generic and interoperable components. Explains ideas underlying generic programming and shows how to create algorithms decoupled from the types and data structures they operate on, and how to write more efficient code that can be used and reused across platforms. Assumes familiarity with C++ and algorithms. Annotation copyrighted by Book News, Inc., Portland, OR

**How to Think Like a Computer Scientist** Addison-Wesley Professional

A textbook that teaches students to read and write proofs using Athena. Proof is the primary vehicle for knowledge generation in mathematics. In computer science, proof has found an additional use: verifying that a particular system (or component, or algorithm) has certain desirable properties. This book teaches students how to read and write proofs using Athena, a freely downloadable computer language. Athena proofs are machine-checkable and written in an intuitive natural-deduction style. The book contains more than 300 exercises, most with full solutions. By putting proofs into practice, it demonstrates the fundamental role of logic and proof in computer science as no other existing text does. Guided by examples and exercises, students are quickly immersed in the most useful high-level proof methods, including equational reasoning, several forms of induction, case analysis, proof by contradiction, and abstraction/specialization. The book includes auxiliary material on SAT and SMT solving, automated theorem proving, and logic programming. The book can be used by upper undergraduate or graduate computer science students with a basic level of programming and mathematical experience. Professional programmers, practitioners of formal methods, and researchers in logic-related branches of computer science will find it a valuable reference.

**A Computer-Based Approach** Walter de Gruyter GmbH & Co KG

Using the C++ Standard Template Libraries is a contemporary treatment that teaches the generic programming capabilities that the C++ 14 Standard Library provides. In this book, author Ivor Horton explains what the class and function templates available with C++ 14 do, and how to use them in a practical context. You'll learn how to create containers, and how iterators are used with them to access, modify, and extend the data elements they contain. You'll also learn about stream iterators that can transfer data between containers and streams, including file streams. The function templates that define algorithms are explained in detail, and you'll learn how to pass function objects or lambda expressions to them to customize their behavior. Many working examples are included to demonstrate how to apply the algorithms with different types of containers. After reading this book, you will understand the scope and power of the templates that the C++ 14 Standard Library includes and how these can greatly reduce the coding and development time for many applications. You'll be able to combine the class and function templates to great effect in dealing with real-world problems. The templates in the Standard Library provide you as a C++ programmer with a comprehensive set of efficiently implemented generic programming tools that you can use for most types of application. How to use Standard Library templates with your C++ applications. Understand the different types of containers that are available and what they are used for. How to define your own class types to meet the requirements of use with containers. What iterators are, the characteristics of the various types of iterators, and how they allow algorithms to be applied to the data in different types of container. How you can define your own iterator types. What the templates that define algorithms do, and how you apply them to data stored in containers and arrays. How to access hardware clocks and use them for timing execution. How to use the templates available for compute-intensive numerical data processing. How to create and use pseudo-random number generators with distribution objects.

**A First Course in Programming and Statistics** Addison-Wesley Professional

In Math for Programmers you'll explore important mathematical concepts through hands-on coding. Filled with graphics and more than 300 exercises and mini-projects, this book unlocks the door to interesting-and lucrative!-careers in some of today's hottest fields. As you tackle the basics of linear algebra, calculus, and machine learning, you'll master the key Python libraries used to turn them into real-world software applications. Summary To score a job in data science, machine learning, computer graphics, and cryptography, you need to bring strong math skills to the party. Math for Programmers teaches the math you need for these hot careers, concentrating on what you need to know as a developer. Filled with lots of helpful graphics and more than 200 exercises and mini-projects, this book unlocks the door to interesting-and lucrative!-careers in some of today's hottest programming fields. Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications. About the technology Skip the mathematical jargon: This one-of-a-kind book uses Python to teach the math you need to build games, simulations, 3D graphics, and machine learning algorithms. Discover how algebra and calculus come alive when you see them in code! About the book In Math for Programmers you'll explore important mathematical concepts through hands-on coding. Filled with graphics and more than 300 exercises and mini-projects, this book unlocks the door to interesting-and lucrative!-careers in some of today's hottest fields. As you tackle the basics of linear algebra, calculus, and machine learning, you'll master the key Python

libraries used to turn them into real-world software applications. What's inside Vector geometry for computer graphics Matrices and linear transformations Core concepts from calculus Simulation and optimization Image and audio processing Machine learning algorithms for regression and classification About the reader For programmers with basic skills in algebra. About the author Paul Orland is a programmer, software entrepreneur, and math enthusiast. He is co-founder of Tachyus, a start-up building predictive analytics software for the energy industry. You can find him online at [www.paulorland.com](http://www.paulorland.com). Table of Contents 1 Learning math with code PART I - VECTORS AND GRAPHICS 2 Drawing with 2D vectors 3 Ascending to the 3D world 4 Transforming vectors and graphics 5 Computing transformations with matrices 6 Generalizing to higher dimensions 7 Solving systems of linear equations PART 2 - CALCULUS AND PHYSICAL SIMULATION 8 Understanding rates of change 9 Simulating moving objects 10 Working with symbolic expressions 11 Simulating force fields 12 Optimizing a physical system 13 Analyzing sound waves with a Fourier series PART 3 - MACHINE LEARNING APPLICATIONS 14 Fitting functions to data 15 Classifying data with logistic regression 16 Training neural networks

[Practical Foundations for Programming Languages](#) Manning Publications

Type-related failures are common and can be very costly. Famously, in 1999, NASA's Mars Climate Orbiter burned up in the atmosphere because of an error that could have easily been prevented with typing. By taking advantage of the strong type systems available in most modern programming languages, you can eliminate whole classes of errors. Programming with Types teaches you type system techniques for writing software that's safe, correct, easy to test and maintain, and that practically documents itself. Master these techniques, and you may even help prevent an interstellar catastrophe! Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications.

[From Mathematics to Generic Programming](#) From Mathematics to Generic Programming

If you want to learn how to program, working with Python is an excellent way to start. This hands-on guide takes you through the language a step at a time, beginning with basic programming concepts before moving on to functions, recursion, data structures, and object-oriented design. This second edition and its supporting code have been updated for Python 3. Through exercises in each chapter, you'll try out programming concepts as you learn them. Think Python is ideal for students at the high school or college level, as well as self-learners, home-schooled students, and professionals who need to learn programming basics. Beginners just getting their feet wet will learn how to start with Python in a browser. Start with the basics, including language syntax and semantics Get a clear definition of each programming concept Learn about values, variables, statements, functions, and data structures in a logical progression Discover how to work with files and databases Understand objects, methods, and object-oriented programming Use debugging techniques to fix syntax, runtime, and semantic errors Explore interface design, data structures, and GUI-based programs through case studies

[Integer Programming](#) Lulu.com

This open access book offers an initial introduction to programming for scientific and computational applications using the Python programming language. The presentation style is compact and example-based, making it suitable for students and researchers with little or no prior experience in programming. The book uses relevant examples from mathematics and the natural sciences to present programming as a practical toolbox that can quickly enable readers to write their own programs for data processing and mathematical modeling. These tools include file reading, plotting, simple text analysis, and using NumPy for numerical computations, which are fundamental building blocks of all programs in data science and computational science. At the same time, readers are introduced to the fundamental concepts of programming, including variables, functions, loops, classes, and object-oriented programming. Accordingly, the book provides a sound basis for further computer science and programming studies.

[How to Specify, Program, and Verify Systems in Rewriting Logic](#) No Starch Press

Shows how to combine mathematical finance and object-oriented programming to practical effect.

[Examples in TypeScript](#) SIAM

Basic Category Theory for Computer Scientists provides a straightforward presentation of the basic constructions and terminology of category theory, including limits, functors, natural transformations, adjoints, and cartesian closed categories. Category theory is a branch of pure mathematics that is becoming an increasingly important tool in theoretical computer science, especially in programming language semantics, domain theory, and concurrency, where it is already a standard language of discourse. Assuming a minimum of mathematical preparation, Basic Category Theory for Computer Scientists provides a straightforward presentation of the basic constructions and terminology of category theory, including limits, functors, natural transformations, adjoints, and cartesian closed

categories. Four case studies illustrate applications of category theory to programming language design, semantics, and the solution of recursive domain equations. A brief literature survey offers suggestions for further study in more advanced texts. Contents Tutorial • Applications • Further Reading

[Introduction to Scientific Programming with Python](#) Simon and Schuster

The fundamental mathematical tools needed to understand machine learning include linear algebra, analytic geometry, matrix decompositions, vector calculus, optimization, probability and statistics. These topics are traditionally taught in disparate courses, making it hard for data science or computer science students, or professionals, to efficiently learn the mathematics. This self-contained textbook bridges the gap between mathematical and machine learning texts, introducing the mathematical concepts with a minimum of prerequisites. It uses these concepts to derive four central machine learning methods: linear regression, principal component analysis, Gaussian mixture models and support vector machines. For students and others with a mathematical background, these derivations provide a starting point to machine learning texts. For those learning the mathematics for the first time, the methods help build intuition and practical experience with applying mathematical concepts. Every chapter includes worked examples and exercises to test understanding. Programming tutorials are offered on the book's web site.

[Fundamental Proof Methods in Computer Science](#) Apress

When programmers list their favorite books, Jon Bentley's collection of programming pearls is commonly included among the classics. Just as natural pearls grow from grains of sand that irritate oysters, programming pearls have grown from real problems that have irritated real programmers. With origins beyond solid engineering, in the realm of insight and creativity, Bentley's pearls offer unique and clever solutions to those nagging problems. Illustrated by programs designed as much for fun as for instruction, the book is filled with lucid and witty descriptions of practical programming techniques and fundamental design principles. It is not at all surprising that Programming Pearls has been so highly valued by programmers at every level of experience. In this revision, the first in 14 years, Bentley has substantially updated his essays to reflect current programming methods and environments. In addition, there are three new essays on testing, debugging, and timing set representations string problems All the original programs have been rewritten, and an equal amount of new code has been generated. Implementations of all the programs, in C or C++, are now available on the Web. What remains the same in this new edition is Bentley's focus on the hard core of programming problems and his delivery of workable solutions to those problems. Whether you are new to Bentley's classic or are revisiting his work for some fresh insight, the book is sure to make your own list of favorites.

[A Gentle Introduction to Numerical Simulations with Python](#) MIT Press

An encyclopedic handbook on audio programming for students and professionals, with many cross-platform open source examples and a DVD covering advanced topics. This comprehensive handbook of mathematical and programming techniques for audio signal processing will be an essential reference for all computer musicians, computer scientists, engineers, and anyone interested in audio. Designed to be used by readers with varying levels of programming expertise, it not only provides the foundations for music and audio development but also tackles issues that sometimes remain mysterious even to experienced software designers. Exercises and copious examples (all cross-platform and based on free or open source software) make the book ideal for classroom use. Fifteen chapters and eight appendixes cover such topics as programming basics for C and C++ (with music-oriented examples), audio programming basics and more advanced topics, spectral audio programming; programming Csound opcodes, and algorithmic synthesis and music programming. Appendixes cover topics in compiling, audio and MIDI, computing, and math. An accompanying DVD provides an additional 40 chapters, covering musical and audio programs with micro-controllers, alternate MIDI controllers, video controllers, developing Apple Audio Unit plug-ins from Csound opcodes, and audio programming for the iPhone. The sections and chapters of the book are arranged progressively and topics can be followed from chapter to chapter and from section to section. At the same time, each section can stand alone as a self-contained unit. Readers will find The Audio Programming Book a trustworthy companion on their journey through making music and programming audio on modern computers.

[3D graphics, machine learning, and simulations with Python](#) John Wiley & Sons

This book begins by explaining key concepts in programming, and elaborates on characteristic of class, including inheritance, derivation and polymorphism. It also introduces generic programming and Standard Template Library, I/O Stream Library and Exception Handling. The concepts and methods are illustrated via examples step by step, making the book an essential reading for beginners to C++ programming.