The Csound Book Perspectives In Software Synthesis Sound Design Signal Processing And Programming

This book discusses all aspects of computing for expressive performance, from the history of CSEMPs to the very latest research, in addition to discussing the fundamental ideas, and key issues and directions for future research. Topics and features: includes review questions at the end of each chapter; presents a survey of systems for real-time interactive control of automatic expressive music performance, including simulated conducting systems; examines two systems in detail, YQX and IMAP, each providing an example of a very different approach; introduces techniques for synthesizing expressive non-piano performances; addresses the challenges found in polyphonic music expression, from a statistical modelling point of view; discusses the automated analysis of musical structure, and the evaluation of CSEMPs; describes the emerging field of embodied expressive musical performance, devoted to building robots that can expressively perform music with traditional instruments.

In Western Civilization Mathematics and Music have a long and interesting history in common, with several interactions, traditionally associated with the name of Pythagoras but also with a significant number of other mathematicians, like Leibniz, for instance. Mathematical models can be found for almost all levels of musical activities from composition to sound production by traditional instruments or by digital means. Modern music theory has been incorporating more and more mathematical content during the last decades. This book offers a journey into recent work relating music and mathematics. It contains a large variety of articles, covering the

historical aspects, the influence of logic and mathematical thought in composition, perception and understanding of music and the computational aspects of musical sound processing. The authors illustrate the rich and deep interactions that exist between Mathematics and Music. Teaching Electronic Music: Cultural, Creative, and Analytical Perspectives offers innovative and practical techniques for teaching electronic music in a wide range of classroom settings. Across a dozen essays, an array of contributors—including practitioners in musicology, art history, ethnomusicology, music theory, performance, and composition—reflect on the challenges of teaching electronic music, highlighting pedagogical strategies while addressing questions such as: What can instructors do to expand and diversify musical knowledge? Can the study of electronic music foster critical reflection on technology? What are the implications of a digital culture that allows so many to be producers of music? How can instructors engage students in creative experimentation with sound? Electronic music presents unique possibilities and challenges to instructors of music history courses, calling for careful attention to creative curricula, historiographies, repertoires, and practices. Teaching Electronic Music features practical models of instruction as well as paths for further inquiry, identifying untapped methodological directions with broad interest and wide applicability.

The contemporary design practice known as data sonification allows us to experience information in data by listening. In doing so, we understand the source of the data in ways that support, and in some cases surpass, our ability to do so visually. In order to assist us in negotiating our environments, our senses have evolved differently. Our hearing affords us unparalleled temporal and locational precision. Biological survival has determined that the ears lead the eyes. For all moving creatures, in situations where sight is obscured, spatial auditory

clarity plays a vital survival role in determining both from where the predator is approaching or to where the prey has escaped. So, when designing methods that enable listeners to extract information from data, both with and without visual support, different approaches are necessary. A scholarly yet approachable work by one of the recognized leaders in the field of auditory design, this book will - Lead you through some salient historical examples of how non-speech sounds have been used to inform and control people since ancient times. - Comprehensively summarize the contemporary practice of Data Sonification. - Provide a detailed overview of what information is and how our auditory perceptions can be used to enhance our knowledge of the source of data. - Show the importance of the dynamic relationships between hearing, cognitive load, comprehension, embodied knowledge and perceptual truth. - Discuss the role of aesthetics in the dynamic interplay between listenability and clarity. - Provide a mature software framework that supports the practice of data sonification design, together with a detailed discussion of some of the design principles used in various examples. David Worrall is an internationally recognized composer, sound artist and interdisciplinary researcher in the field of auditory design. He is Professor of Audio Arts and Acoustics at Columbia College Chicago and a former elected president of the International Community for Auditory Display (ICAD), the leading organization in the field since its inception over 25 years ago. Code and audio examples for this book are available at https://github.com/david-worrall/springer/ Here is an excellent review of the book by Dr Gregory Kramer: "Worrall proceeds bravely through the trees and vines of philosophy, information theory, aesthetics, and other contributors to sonification design theory. It's a feat. He nails all of this down with the specific implementation system he's designed over many years, and

applies his theories to specific problems. In a field of research still in its first half century and setting its bearings in a world where human perception has become a sideshow to machine learning, deep learning, and artificial intelligence, the roots David provides will serve well." Dr Gregory Kramer is the founding figure in the emerging field of sonification, founded the International Conference on Auditory Display (ICAD) and editor of the first book in the field, "Auditory Display: Sonification, Audification and Auditory Interfaces" (Addison Wesley, 1994). This book constitutes the thoroughly refereed post-conference proceedings of the 7th International Conference on Global Security, Safety, and Sustainability (ICDS3), and of the 4th e-Democracy Joint Conferences (e-Democracy 2011) which were held in Thessaloniki in August 2011. The 37 revised full papers presented were carefully selected from numerous submissions. Conference papers promote research and development activities of innovative applications and methodologies and applied technologies.
MUSIC OF THE PEOPLES OF THE WORLD, THIRD EDITION, takes a survey approach to world music, covering 11 music cultures. This text focuses on how to listen to and appreciate the music of different cultures, appropriate for students who are not music majors. The text also explores geography and history, allowing students to connect the music to its social context. Listening skills are developed through spotlights on non-Western instruments, and 30 listening guides track the audio step by step, pointing listeners to important characteristics of the piece. Many full-color photos and graphics of instruments, musicians, and cultural events help students understand the context of music in countries with which they may be unfamiliar. The listening guides, an available 2-CD set (with full selections that help students hear significant differences among the music cultures), and Active Listening Tools (allowing

students to view instruments and cultural settings while they listen to musical excerpts) further enhance listening and understanding. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

Welcome to the Second International IFIP Entertainment Computing Symposium on st Cultural Computing (ECS 2010), which was part of the 21 IFIP World Computer Congress, held in Brisbane, Australia during September 21–23, 2010. On behalf of the people who made this conference happen, we wish to welcome you to this inter- tional event. The IFIP World Computer Congress has offered an opportunity for researchers and practitioners to present their findings and research results in several prominent areas of computer science and engineering. In the last World Computer Congress, WCC 2008, held in Milan, Italy in September 2008, IFIP launched a new initiative focused on all the relevant issues concerning computing and entertainment. As a - sult, the two-day technical program of the First Entertainment Computing Symposium (ECS 2008) provided a forum to address, explore and exchange information on the state of the art of computer-based entertainment and allied technologies, their design and use, and their impact on society. Based on the success of ECS 2008, at this Second IFIP Entertainment Computing Symposium (ECS 2010), our challenge was to focus on a new area in entertainment computing: cultural computing.

Game Sound Technology and Player Interaction: Concepts and Developments researches both how game sound affects a player psychologically, emotionally, and physiologically, and how this relationship itself impacts the design of computer game sound and the development of technology. This compilation also applies beyond the

realm of video games to other types of immersive sound, such as soundscape design, gambling machines, emotive and fantastical sound to name a few. The application for this research is wide-ranging, interdisciplinary, and of primary importance for academics and practitioners searching for the right sounds.

This book constitutes the thoroughly refereed post-proceedings of the International Workshop on Gesture and Sign Languages in Human-Computer Interaction, GW 2001, held in London, UK, in April 2001. The 25 revised full papers and 8 short papers were carefully reviewed and selected for inclusion in the post-proceedings. The papers are organized in topical sections on gesture recognition, recognition of sign languages, nature and notations of sign languages, gesture and sign language synthesis, gestural action and interaction, and applications based on gesture control.

"MEDIACITY: Situations, Practices and Encounters" investigates how the social settings and spaces of the city are created, experienced and practiced through the use and presence of new media. It takes the position that new media enables different settings, practices and behaviours to occur in urban space. Contributions from academics, practitioners and activists from disciplines such as Media Studies, Architecture, Urban Studies, Cultural and Urban Geography and Sociology present a critical reflection on the processes, methods and impacts of technologies in urban space.The MEDIACITY Project seeks to facilitate the transfer of outstanding international knowledge at the Bauhaus-University Weimar in order to intensify

research within the interdisciplinary fields of Media Studies, Architecture and Urban Sociology. It aims to research solutions for urban development in a knowledge based society.

Music Technology and the Project Studio: Synthesis and Sampling provides clear explanations of synthesis and sampling techniques and how to use them effectively and creatively. Starting with analog-style synthesis as a basic model, this textbook explores in detail how messages from a MIDI controller or sequencer are used to control elements of a synthesizer to create rich, dynamic sound. Since samplers and sample players are also common in today's software, the book explores the details of sampling and the control of sampled instruments with MIDI messages. This book is not limited to any specific software and is general enough to apply to many different software instruments. Overviews of sound and digital audio provide students with a set of common concepts used throughout the text, and "Technically Speaking" sidebars offer detailed explanations of advanced technical concepts, preparing students for future studies in sound synthesis. Music Technology and the Project Studio: Synthesis and Sampling is an ideal follow-up to the author's An Introduction to Music Technology, although each book can be used independently. The Companion Website includes: Audio examples demonstrating synthesis and sampling techniques Interactive software that allows the reader to experiment with various synthesis techniques Guides relating the material in the book to various software synthesizers and samplers Links to relevant

resources, examples, and software

An Introduction to Music Technology, Second Edition provides a clear overview of the essential elements of music technology for today's musician. This book focuses on the topics that underlie the hardware and software in use today: Sound, Audio, MIDI, Computer Notation, and Computer- Assisted Instruction. Appendices cover necessary computer hardware and software concepts. Written for both music technology majors and non-majors, this textbook introduces fundamental principles and practices so students can learn to work with a wide range of software programs, adapt to new music technologies, and apply music technology in their performance, composition, teaching, and analysis. Features: Thorough explanations of key topics in music technology Content applicable to all software and hardware, not linked to just one piece of software or gear In-depth discussion of digital audio topics, such as sampling rates, resolutions, and file formats Explanations of standard audio plug-ins including dynamics processors, EQs, and delay based effects Coverage of synthesis and sampling in software instruments Pedagogical features, including: Further Reading sections that allow the student to delve deeper into topics of interest Suggested Activities that can be carried out with a variety of different programs Key Terms at the end of each chapter What Do I Need? Chapters covering the types of hardware and software needed in order to put together Audio and MIDI systems A companion website with links to audio examples that demonstrate various concepts, step-by-step tutorials, relevant hardware, software,

and additional audio and video resources. The new edition has been fully updated to cover new technologies that have emerged since the first edition, including iOS and mobile platforms, online notation software, alternate controllers, and Open Sound Control (OSC).

Users increasingly demand more from their software than ever before—more features, fewer errors, faster runtimes. To deliver the best quality products possible, software engineers are constantly in the process of employing novel tools in developing the latest software applications. Progressions and Innovations in Model-Driven Software Engineering investigates the most recent and relevant research on model-driven engineering. Within its pages, researchers and professionals in the field of software development, as well as academics and students of computer science, will find an up-to-date discussion of scientific literature on the topic, identifying opportunities and advantages, and complexities and challenges, inherent in the future of software engineering.

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.

Sound Tracks is the first comprehensive book on the new geography of popular music, examining the complex links between places, music and cultural identities. It provides an interdisciplinary perspective on local, national and global scenes, from the 'Mersey' and 'Icelandic' sounds to 'world music', and explores the diverse meanings of music in a

range of regional contexts. In a world of intensified globalisation, links between space, music and identity are increasingly tenuous, yet places give credibility to music, not least in the 'country', and music is commonly linked to place, as a stake to originality, a claim to tradition and as a marketing device. This book develops new perspectives on these relationships and how they are situated within cultural and geographical thought. Algorithmic Composition offers new ways of thinking about the organization of sound that we call music

The Handbook of Signal Processing in Acoustics brings together a wide range of perspectives from over 100 authors to reveal the interdisciplinary nature of the subject. It brings the key issues from both acoustics and signal processing into perspective and is a unique resource for experts and practitioners alike to find new ideas and techniques within the diversity of signal processing in acoustics.

This book constitutes the refereed proceedings of the International Conference on the Applications of Evolutionary Computation, EvoApplications 2011, held in Torino, Italy, in April 2011 colocated with the Evo* 2011 events. Thanks to the large number of submissions received, the proceedings for EvoApplications 2011 are divided across two volumes (LNCS 6624 and 6625). The present volume contains contributions for EvoCOMNET, EvoFIN, EvoIHOT, EvoMUSART, EvoSTIM, and EvoTRANSLOC. The 51 revised full papers presented were carefully reviewed and selected from numerous submissions. This volume presents an overview about the latest research in EC. Areas

where evolutionary computation techniques have been applied range from telecommunication networks to complex systems, finance and economics, games, image analysis, evolutionary music and art, parameter optimization, scheduling, and logistics. These papers may provide guidelines to help new researchers tackling their own problem using EC.

This book constitutes the thoroughly refereed post-proceedings of the International Computer Music Modeling and Retrieval Symposium, CMMR 2003, held in Montpellier, France, in May 2003. The 20 revised full papers were carefully selected during two rounds of reviewing and improvement. Due to the interdisciplinary nature of the area, the papers address a broad variety of topics including information retrieval, programming, human-computer interaction, digital libraries, hypermedia, artificial intelligence, acoustics, signal processing, etc. The book comes with a CD-ROM presenting supplementary material for the papers included.

An engaging and user-friendly introduction to the world of music technology, perfect for music students with little technical background.

This is a standalone, but the recipes are correlated with topics found in standard texts, and make use of MAPLE (Release 7). As a reference text, or self-study guide this book is useful for science professionals and engineers.; Good for the classroom correlates with topics found in standard classical mechanics texts.; This book makes use of the powerful computer algebra system MAPLE (Release 7) but no prior knowledge of

MAPLE is presumed.; The relevant command structures are explained on a need-to-know basis as the recipes are developed, thus making this a standalone text.

This book is divided into three elements. Part I provides a broad introduction to the foundations of computer music instruments, covering some key points in digital signal processing, with rigorous but approachable mathematics, and programming examples, as well as an overview of development environments for computer instruments. In Part II, the author presents synthesis and processing, with chapters on source-filter models, summation formulae, feedback and adaptive systems, granular methods, and frequency-domain techniques. In Part III he explains application development approaches, in particular communication protocols and user interfaces, and computer music platforms. All elements are fully illustrated with programming examples using Csound, Python, and Faust. The book is suitable for advanced undergraduate and postgraduate students in music and signal processing, and for practitioners and researchers.

Created in 1985 by Barry Vercoe, Csound is one of the most widely used software sound synthesis systems. Because it is so powerful, mastering Csound can take a good deal of time and effort. But this long-awaited guide will dramatically straighten the learning curve and enable musicians to take advantage of this rich computer technology available for creating music. Written

by the world's leading educators, programmers, sound designers, and composers, this comprehensive guide covers both the basics of Csound and the theoretical and musical concepts necessary to use the program effectively. The thirty-two tutorial chapters cover: additive, subtractive, FM, AM, FOF, granular, wavetable, waveguide, vector, LA, and other hybrid methods; analysis and resynthesis using ADSYN, LP, and the Phase Vocoder; sample processing; mathematical and physical modeling; and digital signal processing, including room simulation and 3D modeling. CDs for this book are no longer produced. To request files, please email digitalproducts-cs@mit.edu.

The essential reference to SuperCollider, a powerful, flexible, open-source, cross-platform audio programming language. SuperCollider is one of the most important domain-specific audio programming languages, with potential applications that include real-time interaction, installations, electroacoustic pieces, generative music, and audiovisuals. The SuperCollider Book is the essential reference to this powerful and flexible language, offering students and professionals a collection of tutorials, essays, and projects. With contributions from top academics, artists, and technologists that cover topics at levels from the introductory to the specialized, it will be a valuable sourcebook both for beginners and for advanced users. SuperCollider, first developed by James McCartney, is

an accessible blend of Smalltalk, C, and further ideas from a number of programming languages. Free, open-source, cross-platform, and with a diverse and supportive developer community, it is often the first programming language sound artists and computer musicians learn. The SuperCollider Book is the long-awaited guide to the design, syntax, and use of the SuperCollider language. The first chapters offer an introduction to the basics, including a friendly tutorial for absolute beginners, providing the reader with skills that can serve as a foundation for further learning. Later chapters cover more advanced topics and particular topics in computer music, including programming, sonification, spatialization, microsound, GUIs, machine listening, alternative tunings, and non-real-time synthesis; practical applications and philosophical insights from the composer's and artist's perspectives; and "under the hood," developer's-eye views of SuperCollider's inner workings. A Web site accompanying the book offers code, links to the application itself and its source code, and a variety of third-party extras, extensions, libraries, and examples.

With the ongoing development of algorithmic composition programs and communities of practice expanding, algorithmic music faces a turning point. Joining dozens of emerging and established scholars alongside leading practitioners in the field, chapters in this Handbook both describe the state of

algorithmic composition and also set the agenda for critical research on and analysis of algorithmic music. Organized into four sections, chapters explore the music's history, utility, community, politics, and potential for mass consumption. Contributors address such issues as the role of algorithms as co-performers, live coding practices, and discussions of the algorithmic culture as it currently exists and what it can potentially contribute society, education, and ecommerce. Chapters engage particularly with post-human perspectives - what new musics are now being found through algorithmic means which humans could not otherwise have made - and, in reciprocation, how algorithmic music is being assimilated back into human culture and what meanings it subsequently takes. Blending technical, artistic, cultural, and scientific viewpoints, this Handbook positions algorithmic music making as an essentially human activity. Containing extensive artwork serving as demonstration, as well as a DVD with sound and video clips, this collection of essays on electroacoustic music explores the creative possibilities to be found in various forms of musical analysis. Taking pitch, duration, intensity, and timbre as the four basic elements of music, the authors discuss electroacoustic works and examine: * the applications of neumes * contemporary staff notation * sound orchestra and score files * time-domain representations * spectrograms. Taking into consideration both the positive

aspects (preservation of the abstract) and negative aspects (creative limitation) of these analytical methods, the authors have created a useful resource for students of electroacoustic music.

Written by an active composer, performer and educator, Sonic Art: An Introduction to Electroacoustic Music Composition provides a clear and informative introduction to the compositional techniques behind electroacoustic music. It brings together theory, aesthetics, context and practical applications to allow students to start thinking about sound creatively, and gives them the tools to compose meaningful sonic art works. In addition to explaining the techniques and philosophies of sonic art, the book examines over forty composers and their works, introducing the history and context of notable pieces, and includes chapters on how to present compositions professionally, in performance and online. The book is supported by an online software toolkit which enables readers to start creating their own compositions. Encouraging a 'hands on' approach to working with sound, Sonic Art is the perfect introduction for anyone interested in electroacoustic music and crafting art from sounds.

Bridging the gap from theory to programming, Designing Software Synthesizer Plug-Ins in C++ For RackAFX, VST3 and Audio Units contains complete code for designing and implementing software synthesizers for both Windows and Mac

platforms. You will learn synthesizer operation, starting with the underlying theory of each synthesizer component, and moving on to the theory of how these components combine to form fully working musical instruments that function on a variety of target digital audio workstations (DAWs). Containing some of the latest advances in theory and algorithm development, this book contains information that has never been published in textbook form, including several unique algorithms of the author's own design. The book is broken into three parts: plug-in programming, theory and design of the central synthesizer components of oscillators, envelope generators, and filters, and the design and implementation of six complete polyphonic software synthesizer musical instruments, which can be played in real time. The instruments implement advanced concepts including a user-programmable modulation matrix. The final chapter shows you the theory and code for a suite of delay effects to augment your synthesizers, introducing you to audio effect processing. The companion website, www.focalpress.com/cw/pirkle, gives you access to free software to guide you through the application of concepts discussed in the book, and code for both Windows and Mac platforms. In addition to the software, it features bonus projects, application notes, and video tutorials. A reader forum, monitored by the author, gives you the opportunity for questions and information exchange.

This book presents comprehensive coverage of the latest advances in research into enabling machines to listen to and compose new music. It includes chapters introducing what we know about human musical intelligence and on how this knowledge can be simulated with AI. The development of interactive musical robots and emerging new approaches to AI-based musical creativity are also introduced, including brain–computer music interfaces, bio-processors and quantum computing. Artificial Intelligence (AI) technology permeates the music industry, from management systems for recording studios to recommendation systems for online commercialization of music through the Internet. Yet whereas AI for online music distribution is well advanced, this book focuses on a largely unexplored application: AI for creating the actual musical content.

A practitioner's guide to the basic principles of creating sound effects using easily accessed free software. Designing Sound teaches students and professional sound designers to understand and create sound effects starting from nothing. Its thesis is that any sound can be generated from first principles, guided by analysis and synthesis. The text takes a practitioner's perspective, exploring the basic principles of making ordinary, everyday sounds using an easily accessed free software. Readers use the Pure Data (Pd) language to construct sound objects, which are more flexible and useful than recordings. Sound is considered as a process, rather than as data—an approach sometimes known as "procedural audio." Procedural sound is a living sound effect that can run as computer code and be changed in real time according to unpredictable events. Applications include video games, film, animation, and media in which sound is part of an interactive process. The book takes a practical, systematic approach to the subject, teaching by example and providing background information that offers a firm

theoretical context for its pragmatic stance. [Many of the examples follow a pattern, beginning with a discussion of the nature and physics of a sound, proceeding through the development of models and the implementation of examples, to the final step of producing a Pure Data program for the desired sound. Different synthesis methods are discussed, analyzed, and refined throughout.] After mastering the techniques presented in Designing Sound, students will be able to build their own sound objects for use in interactive applications and other projects

This book contains a complete and accurate mathematical treatment of the sounds of music with an emphasis on musical timbre. The book spans the range from tutorial introduction to advanced research and application to speculative assessment of its various techniques. All the contributors use a generalized additive sine wave model for describing musical timbre which gives a conceptual unity, but is of sufficient utility to be adapted to many different tasks.

In this new edition of the classic text on the evolution of electronic music, Peter Manning extends the definitive account of the medium from its birth to include key developments from the dawn of the 21st century to the present day. The scope of the many developments that have taken place since the late 1990s are considered in a series of new and updated chapters, including topics such as the development of the digital audio workstation, laptop music, the Internet, and the emergence of new performance interfaces. Emphasizing the functional characteristics of emerging technologies and their influence on the creative development of the medium, Manning covers key developments in both commercial and the non-commercial sectors to provide readers with the most comprehensive resource available on the evolution of this ever-expanding area of creativity.

The Oxford Handbook of Computer Music offers a state-of-the-art cross-section of the most field-defining topics and debates in computer music today. A unique contribution to the field, it situates computer music in the broad context of its creation and performance across the range of issues - from music cognition to pedagogy to sociocultural topics - that shape contemporary discourse in the field. Fifty years after musical tones were produced on a computer for the first time, developments in laptop computing have brought computer music within reach of all listeners and composers. Production and distribution of computer music have grown tremendously as a result, and the time is right for this survey of computer music in its cultural contexts. An impressive and international array of music creators and academics discuss computer music's history, present, and future with a wide perspective, including composition, improvisation, interactive performance, spatialization, sound synthesis, sonification, and modeling. Throughout, they merge practice with theory to offer a fascinating look into computer music's possibilities and enduring appeal.

This rigorous book is a complete and up-to-date reference for the Csound system from the perspective of its main developers and power users. It explains the system, including the basic modes of operation and its programming language; it explores the many ways users can interact with the system, including the latest features; and it describes key applications such as instrument design, signal processing, and creative electronic music composition. The Csound system has been adopted by many educational institutions as part of their undergraduate and graduate teaching programs, and it is used by practitioners worldwide. This book is suitable for students, lecturers, composers, sound designers, programmers, and researchers in the areas of music, sound, and audio signal processing.

This text reflects the current state of computer technology and music composition. The authors offer clear, practical overviews of program languages, real-time synthesizers, digital filtering, artificial intelligence, and much more.