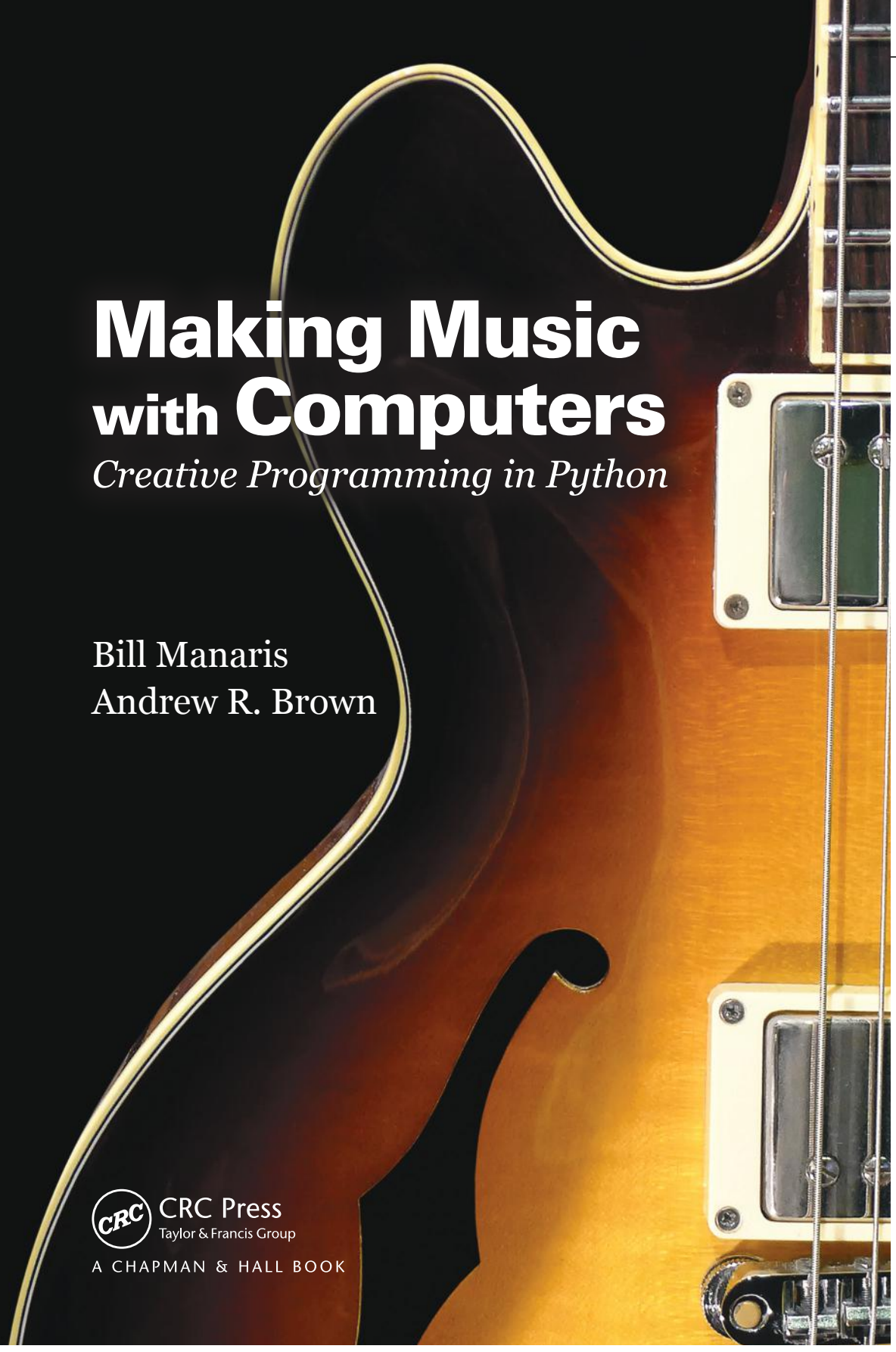

Making Music with Computers

Creative Programming in Python

Bill Manaris
Andrew R. Brown

CRC Press
Taylor & Francis Group
A CHAPMAN & HALL BOOK

Making Music with Computers

Creative Programming in Python

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Bill Manaris
College of Charleston
South Carolina, USA

Andrew R. Brown
Queensland University of Technology
Keperra, Australia

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Foreword

The human desire to express and communicate has influenced computing almost as long as there have been computers. ENIAC was first turned on in 1947. The first computer music was generated in 1957.

The desire to *say* more with a computer has driven many advances in computer science. Ivan Sutherland invented interactive computer graphics in 1963, and his creation inspired the idea of classes in object-oriented programming. Alan Kay and Adele Goldberg described the computer as human's first *meta-medium*, the first creative medium that could encompass all previous media. Their research group at Xerox's Palo Alto Research Center (PARC) worked in the 1970s to answer the question, "What would a computer used for creative expression look like?" That's what led them to invent the desktop user interface as we know it today. In a real sense, the menus and windows that we use today to access Facebook were invented in order to make the most powerful tool ever for human expression.

Making music on a computer is a natural way to learn more about mathematics, computer science, and music. Bill Manaris and Andrew Brown have created this marvelous book that will engage and inspire you to learn more about the science and art of creating music through computation. They lead us through exploration of fascinating questions. How does music draw on both mathematical patterns and randomness? How did Bach use algorithms to generate canons? How can we turn data about proteins and planets into music? What kinds of new interfaces can you create to make it easier for you and others to make music?

Bill and Andrew offer an accessible path into a wonderful world that is both as modern as your new laptop and as ancient as Plato. In that world of music and mathematics, they constructed a sandbox of computational

tools. They encourage you to create, to compose music, and to play with patterns and data. They invite you to continue in the traditions of Ivan Sutherland and Alan Kay to use computing to explore powerful and creative ideas.

Mark Guzdial
Georgia Institute of Technology
July 2013

Preface

The book in your hands is the result of more than a decade of independent and collaborative effort by the two authors and their computer music associates. Combining computers and music has a long and fruitful heritage. The ideas which underpin the connection between calculating and composing date back centuries. In the 21st century, computers and music are more closely aligned than ever before. In particular, computers have become indispensable in music making, distribution, performance, and consumption.

This book introduces important concepts and skills necessary to make music with computers. It interweaves computing pedagogy with musical concepts and creative activities. It does this while maintaining a natural, steady increase in computational skills that are motivated by creative musical contexts.

This book is intended primarily for introductory computer science courses and for courses in the intersection of computing and the arts. However, it is naturally suited for self-study. It assumes little musical and programming experience; it introduces topics and concepts as they arise through motivating, and hopefully inspiring examples.

CREATIVE PROGRAMMING

"Making Music with Computers" is an introduction to creative software development in the Python programming language. It uses music-making as a vehicle to introduce computer programming and computational thinking to non-traditional audiences. This book helps computer science educators teach students how to synthesize the creativity and design of the arts with the mathematical rigor and formality of computer science.

Initially inspired by Randy Pausch's "head-fake" approach*, we utilize exciting and innovative music-creation activities to ultimately teach

* See Randy Pausch's "Last Lecture" (readily available online).

introductory computer science concepts. Our goal is to keep this "game" going throughout the book, just long enough so that the students learn to express themselves algorithmically.

The book covers all concepts found in a traditional "Intro to Computer Programming" (CS1) course. These concepts include data types, variables, assignment, arithmetic operators, input/output, algorithms, selection (`if` statements), relational operators, logical operators, iteration (loops), lists (arrays), functions, modularization (functions), classes (object-oriented programming). Additionally, the book covers graphical user interfaces (GUIs), event-driven programming, big data, MIDI programming, client-server programming (via OSC messages), recursion, fractals, and complex system dynamics (boids).

TARGET AUDIENCE

This book addresses two trends in computing education: (1) the growing use of the Python language for teaching introductory programming, and (2) the increasing infusion of computational thinking into liberal arts courses, especially interdisciplinary offerings in computing and the arts. It does so by presenting computer music topics in an accessible way for our two main target audiences:

- First- and second-year university students, as well as advanced high school students, who are interested in computer music and wish to learn computer programming in a creative context; and
- Musicians of all levels and backgrounds who wish to expand their creative horizons by modeling musical processes through computer programming, and by applying these processes to create novel and intriguing musical material for composition and live performance.

NAVIGATING THE BOOK

The book may be navigated using one of three narratives, *objects first, procedures first,* or *à la carte:*

- **Objects first** (chapters 1–3, followed by chapters 8–11, with just-in-time introduction of `for` loops, functions, and `if` statements). This approach works well with inexperienced students, as it is creatively rich. It includes building graphical user interfaces (GUIs) and interactive musical instruments, and thus motivates hard-to-grasp