

Preface

This book addresses a fundamental question about music cognition: how do we extract basic kinds of musical information—meter, phrase structure, counterpoint, pitch spelling, harmony, and key—from music as we hear it? My approach to this question is computational: I develop computer models for generating these aspects of structure, with the aim of simply solving the computational problems involved as elegantly and effectively as possible, and with the assumption that this approach may shed light on how the problems are solved in cognition. The models I propose are based on *preference rules*. Preference rules are criteria for evaluating a possible analysis of a piece (in terms of some kind of musical structure). In a preference rule system, many possible interpretations are considered, and the one is chosen that best satisfies the rules.

I begin with an introductory chapter, describing the overall goals and methodology of the project and overviewing the theoretical and implementational strategy. The remainder of the book is then divided into two parts. In part I, I present preference rule systems for generating six basic kinds of musical structure. *Metrical structure* is a framework of levels of beats. *Melodic phrase structure* is a segmentation of the input into phrases; the model I propose is applicable only to melodies, not polyphonic textures. *Contrapuntal structure* is a segmentation of a polyphonic texture into melodic lines. *Pitch spelling*, which I also call the *tonal-pitch-class representation*, involves a labeling of pitch events in a piece with spellings (“tonal-pitch-class” labels) such as $A\flat$ or $G\sharp$. *Harmonic structure* is a segmentation of a piece into harmonic segments labeled with roots. The preference rule systems for pitch spelling and harmonic struc-

ture are closely integrated, and really represent a single preference rule system. Finally, *key structure* is a segmentation of a piece into larger sections labeled with keys.

A separate chapter is devoted to each preference rule system. In each case, I begin by describing the basic character of the structure in question; I also review any psychological evidence pertaining to it (both the psychological reality of this kind of structure and the way it is inferred in perception). I then discuss earlier computational proposals (if any) for how this structure is inferred. My own preference-rule approach to this problem is then presented in an informal, conceptual way, with discussion of each preference rule and the motivation for it. Next, I discuss the implementation of the model in more technical detail. Finally, I present any formal tests that were done of the model; in each case, at least one such test was performed. I examine flaws in the model revealed by the tests, and consider possible improvements.

A central claim of the current study is that preference rule systems are not merely valuable as proposals for how musical structures are inferred, but also shed light on other aspects of music. The second half of the book attempts to substantiate this claim. I begin in chapter 8 with a discussion of three important aspects of musical experience: ambiguity, retrospective revision, and expectation. The following two chapters explore the possible relevance of preference rule systems to kinds of music outside the Western canon. Chapter 9 applies the metrical, harmonic and key models to rock music; chapter 10 examines the validity of the metrical and phrase structure models for traditional African music. Chapter 11 considers how preference rule systems might be applied to issues of composition and performance, and proposes a framework for the description of musical styles. Finally, in chapter 12, I explore the relevance of preference rule systems to higher-level musical structure and meaning; here I address issues such as motivic structure, musical schemata (gestures or patterns with conventional associations), narrative and dramatic aspects of music, and musical tension.

The content of this book is, in a sense, two-dimensional. With each preference rule system, there are a number of issues to be addressed: basic issues such as psychological evidence, the preference rule system itself, and implementation and testing, as well as more speculative issues such as those addressed in part II. It was difficult to know how to traverse this two-dimensional space in the linear fashion required for a book. I am well aware, however, that not all readers will be interested in all the issues covered here. The sections in part I in which I overview each

preference rule system (as well as those relating to psychological evidence and earlier computational approaches) are intended to be interesting and accessible to a broad audience: music theorists and musicians, music psychologists and others in psychology, and workers in music technology and artificial intelligence. In these sections, I try to avoid assuming great knowledge of music theory, and provide at least some explanation of any advanced musical terms that I use. (Even so, these sections will undoubtedly prove more rewarding to those with some knowledge of music; in particular, an ability to imagine simple musical excerpts or play them on a keyboard will be useful, since it will enable readers to compare my claims about musical perception with their own intuitions.) Sections in part II may, obviously, be of special concern to certain audiences with interests in African music, the psychology of performance and composition, and the like, though here again I aim to make the material broadly accessible. The most narrowly aimed sections of the book are those relating to the implementation and testing of each preference rule system (roughly speaking, the final part of each chapter in part I, as well as the section on implementation in the introductory chapter). These are primarily intended for those in the area of computational music analysis, who may wish to learn from or evaluate my implementational approach and compare the performance of my models to their own models or others. Other readers may wish to skip over these sections; they are not essential for understanding the rest of the book.

The computer implementations presented here are publicly available at the website www.link.cs.cmu.edu/music-analysis. (The implementations of the meter, pitch spelling and harmony programs were developed in collaboration with Daniel Sleator.) The programs are written in C, and run on a UNIX platform. The website also provides many of the input files for excerpts discussed in this book. I hope this will encourage others to experiment with the programs, and subject them to further testing; those with alternative models may wish to try their programs on the same input files used in my tests.