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Soubhik Chakraborty • Guerino Mazzola •
Swarima Tewari • Moujhuri Patra

Computational Musicology in Hindustani Music

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Soubhik Chakraborty
Swarima Tewari
Department of Applied Mathematics
Birla Institute of Technology
(BIT), Mesra
Ranchi, Jharkhand
India

Guerino Mazzola
School of Music
University of Minnesota
Minneapolis, MN
USA

Moujhuri Patra
Dept. of Computer Applications
Netaji Subhash Engineering Coll (NSEC)
Kolkata, West Bengal
India

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Preface

Computational musicology is the fruit of two factors that were brought to florescence in the twentieth century: modern mathematics and computer technology. The mathematical contribution can be attributed to an incredible expansion of the mathematical concept architecture, reaching far beyond simple numbers and functions. The culmination of this development can be concretized in the theory of topoi that was initiated by Alexander Grothendieck and ultimately unites geometry and logic in a revolutionary restatement of what is a space, namely, that concepts are understood as being points in a conceptual space. Mathematical music theory has drawn substantially from topos theory, as has become evident with the publication of *The Topos of Music* (Mazzola 2002). A concrete consequence of this development has been a computational description and modeling of fundamental topics of music theory: harmony, rhythm, melody, counterpoint, performance, and composition.

But it became evident very soon that such computational approaches could only be related to existing musical works with powerful computational tools, much as modern physics cannot be developed without impressive experimental devices, such as particle accelerators and their computational background machinery. In fact, a melodic analysis of a one-page composition can easily imply billions of comparisons of motivic units. This suggests a future musicology that might move in the direction of big science when it comes to understanding major works in music, be it in the Western classical score-driven tradition, in the Indian raga tradition, or in free improvisation. This is why music software has been developed to calculate quantitative results that reflect the theoretical models of computational musicology. The RUBATO software (Mazzola and Zahorka 1994) was one of the first tools that offered comprehensive analytical machinery for computational harmonic, rhythmical, melodic, and performance-theoretical investigations. It is not by chance that such investigations were first conducted in collaboration with a statistician (Beran and Mazzola 1999) since experimental science cannot be realized without statistical methods. Statistics in musicology has become a fascinating new field of research (Beran 2004). These investigations have revealed significant relations between the

analytical structure of classical Western compositions and the tempo curves of human performances (Mazzola 2002).

In this sense, we are proud of having supported the opening of a path to a deeper understanding of the great Indian raga tradition, which is not score driven but builds on a deep oral canon of gestural creation and communication (Rahaim 2012). This tradition would be difficult to analyze in precise terms without mathematical music theory, its technology, and the statistical methodology of experimental research.

Chapter 1 gives an introduction to Indian music, with special emphasis on Hindustani classical music and its critical comparison with Western classical music; it was written by the first two authors. In the critical comparison the authors even contradicted themselves, but neither view can be discarded. This chapter will immensely help music enthusiasts who have knowledge of Western classical music but are new to Indian music.

Chapter 2 talks about the role of statistics in computational musicology; it was written by the first author. Chapter 3 describes RUBATO, the music software for statistical analysis; it was written by the second author. Chapters 4–6 teach us how to analyze a musical structure using a statistical approach; they were written by the third author and the first author. In particular, Chap. 4 deals with modeling, Chap. 5 with melodic similarity and lengths, and Chap. 6 with entropy analysis. These three chapters explain how and why it becomes important to bring out some general features of a musical piece (in this case, a raga) structurally without bringing the style of the artist into play. This style, however, provides additional features demanding further statistical analysis, and consequently the problem of analyzing a musical performance is addressed in Chaps. 7 and 8. Chapter 7 is focused on modeling, wherein the strength of the statistical approach lies; it was written by the fourth author and the first author. Chapter 8 gives a statistical comparison of a morning raga (Bhairav) and a night raga (Bihag) using RUBATO; it was written jointly by the first three authors.

Raga-based songs are important in promoting Indian classical music among laymen. Chapter 9, written by the third author and the first author, explains how the concept of seminatural composition, using a Markov chain of first order, can help a music composer in obtaining the opening line(s) of a raga-based song using Monte Carlo simulation. Once this opening line is obtained, the song can be completed by any intelligent composer. It is the opening line that is crucial, and this is where musical plagiarism comes into play.

Chapter 10 summarizes the first author's practical experience of presenting the science of music together with the art of music on stage with professional artists, and it provides the scheme and motivation for doing so. It also briefly explains why it is important to achieve success in computational musicology in order to achieve success in music therapy.

This book, written with the sole objective of promoting computational musicology in Indian music, is primarily aimed at teaching how to do music analysis in Indian music, although most of the concepts are applicable in other genres of music as well. It assumes that the musical data is already available either from text

(structure) or from audio samples (performance). Thus, this is not a book that teaches you how to acquire the musical data using signal processing. Consequently, several aspects of music analysis involving signal processing such as raga identification and tonic (Sa) detection had to be left out, and we have provided references for these. One reason is that while there are many good books available on musical signal processing (see, e.g., Roads et al. 1997; Klapuri and Davy 2006), there were no books on computational musicology in Indian music. Most of the works are available as research papers, and, apart from those that are published online, they are not accessible unless you or your institute has a subscription for the journal concerned. Hopefully this book will meet some of the requirements of a music analyst interested in Indian music. A second reason is that we had to consider the overall size of this book.

However, musical signal processing is an interesting area of music research, and we promise to write a book on music information retrieval (MIR) in the context of Indian music in the near future, in which we would deal extensively with musical signal processing. Most of the issues that could not be addressed here would be taken up then.

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Ranchi, India — Soubhik Chakraborty
Minneapolis, MN, USA — Guerino Mazzola
Ranchi, India — Swarima Tewari
Kolkata, India — Moujhuri Patra
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