

Chapter XLVI

Music Information Retrieval

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ABSTRACT

This chapter provides an overview of the relatively young but increasingly important domain of Music Information Retrieval, an Information Retrieval subdomain, which investigates efficient and intelligent methods to analyze, recognize, retrieve and organize music. After describing the background and the problems that are addressed by research in this domain the chapter gives a brief introduction to methods for the extraction of semantic descriptors from music, which are fundamental to a great number of tasks in Music Information Retrieval. In the subsequent sections, music retrieval, music classification and music library visualization systems are described. All of these systems are developed for the purpose of enhancing organization, access and retrieval in potentially large digital music libraries.

INTRODUCTION

The increasing popularity and size of digital music libraries, both professional repositories and personal audio collections, calls for advanced methods for efficient organization and retrieval. Traditional search based on file name, song title, or artist does not meet the advanced requirements of people working with large music libraries because it either presumes exact knowledge of these meta-data or involves browsing of long lists in the archive.

Modern Music Information Retrieval (MIR) systems rely on content-based music similarity and offer a multitude of new technologies to organize, access and explore digital music libraries. A range of different feature extraction techniques has been developed, which analyze music and extract descriptors that allow computing similarity between pieces of music. On top of the features extracted from music, standard information retrieval techniques are applied in order to enable to search for specific pieces of music, or for tracks from a certain musical genre.

Queries may be formulated by providing audio examples: example songs, excerpts of recorded audio or even hummed melodies. MIR systems then retrieve music by computed similarity.

The application of machine learning algorithms enables classification of music by artist, by genre or other categories, using the extracted music descriptors. These methods allow a MIR system to detect music from a particular artist, to recognize the genre of a piece of music or even its mood, or to organize an entire music library into a pre-defined genre taxonomy. By contrast, the use of unsupervised learning techniques overcomes genre boundaries and considers audio similarity independently from genre labels. These approaches facilitate the organization of a digital music library by an automatic clustering of the pieces of music. Clusters containing similar music are exhibited by a variety of visualizations. One particular approach that has been chosen is the use of Self-Organizing Maps (SOMs) to create maps of music libraries. A range of different visualization methods developed for SOMs enhance the view of the cluster structures in the music library. Applications have been developed that facilitate interaction with the digital music library, retrieval of music and discovery of yet unknown music. Together with ad-hoc creation of style- and situation-based playlists, these systems allow for novel methods of access to digital music libraries.

BACKGROUND

The term *Music Information Retrieval* has been first mentioned by Kassler (1966). For a long period, however, there was little research on this topic. First beat detection systems were published in the late 1970s and 1980s. The domain of content-based music retrieval experienced a major boost in the late 1990s when mature techniques for the automated description of the content of music became available. In the 1990s, also first systems for classification and clustering of sound

events (Feiten & Günzel, 1994) and discrimination of speech and music (Scheirer & Slaney, 1997) were presented. The first works on music style recognition were using MIDI or other symbolic music as input (Dannenberg, Thom, & Watson, 1997). Then, research on audio-based approaches for music classification became increasingly important (Foote, 1997). Since around 2000, the problem of clustering and visualizing large music libraries and supporting better access to them has been addressed.

The International Conference on Music Information Retrieval (ISMIR) is the most important forum for researchers and people interested in Music IR. In the annual MIREX (Music Information Retrieval Evaluation eXchange) benchmarking event, state-of-the-art approaches for music description, classification and other tasks are evaluated and compared.

Downie (2003) provides a review of nearly all aspects of Music Information Retrieval, including contributions from the pre-digital era. The review covers different classes of music descriptors, describes a range of MIR systems and discusses also the challenges in MIR. Orio (2006) explains and reviews different aspects of music and music processing, discusses the role of the users, and gives an introduction to scientific MIR evaluation campaigns. He also describes several systems for MIR.

MUSIC DESCRIPTORS

An essential part of most Music Information Retrieval tasks is the automatic description of music. As computers are not capable to grasp semantics in music directly, algorithms have been devised that extract (numerical) features from music which capture aspects such as loudness, tempo, beat, rhythm, timbre, pitch, harmonics, melody, and so on. These features are also called music descriptors.

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