Chapter II

MARSYAS–0.2: A Case Study in Implementing Music Information Retrieval Systems

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ABSTRACT

MARSYAS is an open source audio processing framework with specific emphasis on building music information retrieval systems. It has been under development since 1998 and has been used for a variety of projects in both academia and industry. In this chapter, the software architecture of Marsyas will be described. The goal is to highlight design challenges and solutions that are relevant to any MIR software.

INTRODUCTION

Advances in technology have always transformed music. Examples of technologies that transformed the way music was produced, distributed and consumed include musical instruments, music notation, recording and more recently digital music storage and distribution. Recently portable digital music players have become a familiar sight and online music sales have been steadily increasing. It is likely that in the near future anyone will be able to digitally access all of recorded music in human history. In order to efficiently interact with the rapidly growing collections of digitally available music it is necessary to develop tools that have some understanding of the actual musical content. Music information retrieval (MIR) is an emerging research area that deals with all aspects of organizing and extracting information from music signals.
In the past few years, interest in music information retrieval (MIR) has been steadily increasing. MIR algorithms, especially when analyzing music signals in audio format, typically utilize state-of-the-art signal processing and machine learning algorithms. The large amounts of data that are processed together with the huge computational requirements of audio processing can stress current hardware to its limits. Therefore efficient processing is critical for building functional MIR systems that scale to large collections of music and eventually to all of recorded music. Moreover, MIR is an inherently interdisciplinary field with practitioners with varying degrees of computer and programming expertise (examples of fields involved include musicology, information science and cognitive psychology). Therefore it is desirable for MIR systems to support multiple hierarchical levels of usage and extensibility. These issues make the design and development of MIR systems and frameworks especially challenging.

MARSYS (Music Analysis, Retrieval and Synthesis for Audio Signals) is an open source audio processing framework with specific emphasis on building MIR systems. It has been under development since 1998 and has been used for a variety of projects both in academia and industry. The guiding principle behind the design of MARSYS has always been to provide a flexible, expressive and extensive framework without sacrificing computational efficiency. Addressing these conflicting requirements is the major challenge facing the software engineer of MIR systems.

The main objective of this chapter is to describe the software architecture of MARSYS using examples from specific MIR applications. We highlight the design challenges and corresponding solutions that are probably relevant to any MIR software system. In many cases these solutions are informed by ideas originating from other fields of computer science and software engineering but have to be adapted to the particular needs and constraints of MIR research. After reviewing related work and background information, MARSYS is described in the following subsections: History, Requirements, Architecture and Projects. The next section (Specific Topics) describes in more detail specific topics that we believe are especially important for audio processing and how we have tried to address them in the framework. The chapter concludes with a description of future trends in MARSYS and audio processing software frameworks in general. One of the major dilemmas facing any MIR researcher is whether to use existing tools or develop their own. By describing the tradeoffs and challenges we have faced with the design of our system we hope to help researchers make more informed decisions. Finally an underlying theme of this chapter is the importance of open source software for research and how it is different from other areas of open source development.

BACKGROUND

Music Information Retrieval is a new area of content-based multimedia information retrieval. Although there was sporadic earlier work, a good reference starting point is the first international conference on MIR (ISMIR) which was held in 2000. These conferences (ISMIR) have been a forum for bringing together music researchers, audio engineers, computer scientists, musicologists, librarians and the music industry (Futrelle & Downie, 2002). MIR with audio signals typically requires signal processing and machine learning algorithms in order to achieve tasks such as classification, similarity-retrieval and segmentation.

MARSYS 0.2, the software framework for audio analysis and synthesis described in this chapter, evolved from MARSYS 0.1 (Tzanetakis & Cook, 2000), a framework that focused mostly on audio analysis. One of the motivating factors for the rewrite of the code and architecture was the desire to add audio synthesis capabilities and was influenced by the design of the Synthesis Toolkit.
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