A Digital Library Data Model for Music

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ABSTRACT

In this paper, we introduce a data and metadata model being developed for use in a music digital library system to support search and navigation of music content in multiple formats.

Categories and Subject Descriptors

H.3.7 [**Information Storage and Retrieval**]: Digital Libraries; H.2.1 [**Database Management**]: Logical Design – *data models*; J.5 [**Arts and Humanities**] – *performing arts*.

General Terms

Design, Documentation.

Keywords

Music, digital libraries, data models, metadata.

1. INTRODUCTION

Creating a digital music library requires addressing complex issues of description, representation, organization, and use of music information. The fundamental question to be addressed is the nature of associations that exist among various types of musical objects. A single musical work can be manifested in a range of physical formats: as one or more scores, sound recordings, and video recordings, each of which may exist in multiple digital formats in a digital library system. These manifestations all share some properties of the original work but also possess unique characteristics. A bibliographic search for music typically involves both "global" work properties and "local" characteristics of its various manifestations: names of composers or performers, musical genres, styles, keys, copyright information, instrumentation, structure, media formats, and various types of publication information. Current bibliographic systems based on the USMARC format [5] do not adequately support the special requirements of music description and searching and do not take full advantage of the relationships between the manifestations of a musical work.

2. DATA MODEL OVERVIEW

One of the goals of the *Variations2* digital music library project [3] at Indiana University is the development of a data model that aims to overcome the limitations of traditional library databases and to accommodate the special needs of the music domain in several ways. First of all, it identifies, separates, and relates the logical and physical layers of musical works and their physical manifestations into four entities: The *Work* represents the abstract concept of a musical composition or set of compositions. The *Instantiation* represents a manifestation of a work as a performance or a score. The *Container* represents the physical item or set of item(s) on which one or more instantiations of works can be found, e.g. a CD or published score. The *Media Object* represents a piece of digital media content, such as a sound file or score image. *Contributors* represent people or groups that contribute to a work, instantiation, or container.

The following figure demonstrates the entities and relationships in the *Variations2* data model and provides an example of a musical work represented by the model:
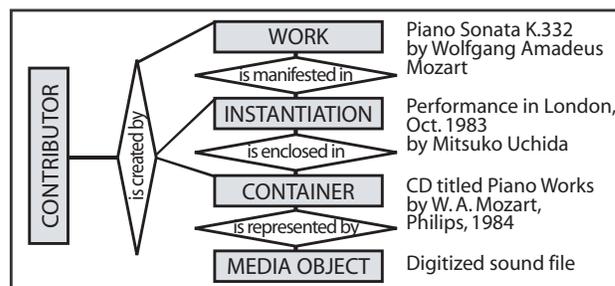

Figure 1. Data model example.

This multidimensional model offers several advantages over the traditional flat MARC database structure, which centers on the physical container. This model is designed to improve data accuracy (names, titles, and other global identifying concepts are entered once and linked to appropriate entities) and improve comprehensiveness and precision of search results (a work is linked to all its instantiations, the roles of contributors are clearly delineated and linked to appropriate entities, etc.). In addition, it presents a flexible logical structure that allows for richer and more precise description of musical entities, which should improve music information representation and retrieval.

Each entity is represented by appropriate descriptive, administrative, and structural metadata. The main purpose of descriptive metadata in the *Variations2* model is to assist users in

discovery and identification of various music objects through searching and browsing. In defining descriptive metadata elements, an effort was made to allow for mapping from USMARC as much as possible (though limited by fundamental structural differences between the models). Some beneficial features of USMARC include its authority records, which roughly resemble the *Variations2* contributor and work records, and the relative validity of its data, which serves as source information for some of the important *Variations2* attributes such as names, titles, and dates. In addition to descriptive metadata, administrative metadata elements have been defined for each entity to accommodate various managerial concerns including record maintenance, digitization properties, and rights management.

The *Variations2* model is similar to the schema developed by the International Federation of Library Associations (IFLA) Study Group on the Functional Requirements for Bibliographic Records [2]. Both projects rely on entity-relationship analysis to identify key concepts, their associations, and properties. The differences between the two models arise from the fact that the *Variations2* data model has been designed specifically for digitized music information, while the IFLA proposal deals with more general bibliographic requirements.

3. STRUCTURAL ACCESS

One of the music-specific aspects of the *Variations2* model is its ability to not only relate multiple instantiations of a musical work at the work level, but also to support linking at the structural level through use of structural metadata elements.

Structural metadata has been used in other music digital library systems [1][4] to store information on track descriptions and time or page number offsets in order to provide users with navigation capabilities within a given recording or score. In the *Variations2*, structural metadata of this form is attached to each container object as *container structure*. However, the *Variations2* model also incorporates structural metadata in two additional forms: *work structure* and *work bindings*. The work structure outlines the basic structure of a given musical work, defining major elements such as movements of a symphony, acts and scenes of an opera, etc., and optionally more detailed elements, that are independent of any given instantiation. Each section defined in the work structure is given a unique label.

Work bindings are associated with each instantiation and serve to tie particular time or page ranges within the media objects of a given instantiation to the abstract structure of the corresponding work. Depending on the detail entered, these bindings may connect instantiations only at a few points or all the way down to the measure level. Obviously, work on automated methods for synchronization of scores and recordings will be essential for creation of significant structural metadata at a detailed level.

4. CURRENT STATUS & FUTURE PLANS

The first version of the *Variations2* testbed system, to be completed in March 2002, supports delivery of streamed digital audio and scanned scores to users at Indiana University Bloomington and additional satellite sites, and provides a search user interface which takes advantage of descriptive metadata in the data model to assist the user in refining specified contributors, musical works, and recordings. The data model is implemented using a relational database, with an XML representation of objects for import and export. We plan to undertake user testing to compare usability and search performance with more traditional keyword-search-based USMARC catalog interfaces.

In future versions, we plan to take greater advantage of the structural capabilities of the model by developing user interfaces for synchronized navigation and playback of objects. Such synchronization will open up possibilities for music study and instruction by allowing performers to easily compare multiple performances of a given work synchronized to the score, enabling musicologists to more easily compare different score editions, and letting beginning theory students study and move about a score online while hearing a real performance.

Work is also underway to develop a thesaurus of terms for use in form/genre, instrumentation, and other descriptive metadata elements to enhance description and improve search functionality.

We also plan to explore implementation of the data model using relevant emerging standard schemes such as MPEG-7, MPEG-21 [7], and METS [6].

5. ACKNOWLEDGMENTS

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