Music Representation in a Digital Music Library

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Abstract

The Variations2 digital music library currently supports music in audio and score-image formats. In a future version, we plan to add music in a symbolic form. This paper describes our work defining a music representation suitable for the needs of our users.

1. Introduction

Variations2 is a large-scale digital music library project under development at Indiana University [10]. Version 1 of the software for *Variations2* is now complete. For that version, the digital library contains music in audio and score-image (i.e., scanned) forms. A future version will also support symbolically represented music. Music in symbolic form will be useful to a wide range of people for a wide range of applications, including:

1. music faculty creating assignments and teaching classes (for showing and playing musical examples, plus analyses of those examples);
2. students enrolled in classes with these faculty (for assignments involving tasks such as re-composition or model composition);
3. faculty and student music researchers doing content-based analytical or historical research;
4. music library patrons who for some reason are not content with scanned (or printed!) scores.

Because a large number of symbolic music representations already exist, it makes sense to use one of these rather than to develop a new representation from scratch. But on what basis can we determine which of these representations are satisfactory, and how can we choose which of them is best suited to our needs? While the published literature on music representation is substantial—a few relevant works are [4], [5], [6], and [8]—we know of nothing like a formal description of the requirements for a music representation in any situation. This paper gives an overview of our work to develop such a description for a digital music library.

2. Design Basis

Wiggins et al. [11] discuss three sorts of tasks a symbolic music representation might be used for: (1) recording, in which "the user wants a record of some musical object, to be retrieved at a later date"; (2) analysis, in which the user "wants to retrieve not the 'raw' musical object, but some analyzed version"; and (3) generation/composition. Of these, we are concerned (in view of our expected users and uses listed above) most with the first, less with the second, and least with the third. Declarative representations—by far the more familiar type to most people—rather than procedural ones are much more appropriate for the first type of task and usually for the second, so we consider only declarative representations.

We used [3] to determine the required extent of support for certain types of features, such as the highest, lowest, longest, and shortest notes; the largest numbers of voices and of staves in a score; and so on.

3. Domains of Music Information

The groundbreaking Mockingbird music editor [6] pioneered the approach of storing independently information about the *logical, performance* (also called *gestural*), and *graphic* aspects of music. Logical information about a note might include that it is a quarter note; performance information, that it lasts for 600 milliseconds; and graphic information, that it has a diamond-shaped notehead. Several programs, e.g., [1], adopted Mockingbird's approach; SMDL [9] added a fourth "domain," for *analytic* information, which might include information on the underlying harmony or phrase structure, for example.

For a digital music library project, the independent-domain model has a number of advantages. The need for independent logical and performance information is not hard to see. Even if a program can generally play "musically" on its own, it may not be able to handle cadenzas or other passages involving rubato, and it certainly will not be able to reproduce Heifetz's interpretation as distinct from Salerno-Sonnenberg's. The need for graphic information independent of logical is less obvious, but Byrd [2] cites many "counterexamples." To name just two, instances exist in Debussy of clefs in mid-air below the staff, and in Chopin of single noteheads that simultaneously represent normal 16^{th} notes in one voice but triplet 16ths in another voice. Finally, there is little chance a program will be able to produce a high-quality harmonic analysis in the near future, to name just one of many forms of music analysis used in an academic setting; hence the need to be able to store analytic information. Therefore, we strongly advocate SMDL's version of this independent-domain model.

Given likely uses of a music representation in a digital music library, there is no need to represent publishable scores, only serviceable renderings of notation. Therefore the graphic domain is less important than it otherwise would be. But rendering complex music in even a serviceable way is difficult (see [2]; [7] describes limitations of well-known programs in some detail). So representing graphic "tweaking" is still important.

4. Specification Overview

Reflecting its target use at the Indiana University School of Music, the music-representation requirements specification we developed is heavily oriented towards "classical" (western art) music, though we believe it is comprehensive enough to be useful for other styles, e.g., jazz and popular music. We require some sort of schema (including XML DTDs): among several advantages of schemas is the automatic validation of data.

There are some 230 items in 24 categories:

0. Global Information
1. Voices, Staves, and Parts
2. MIDI Channels, Cables, and Patches
3. Musical Symbols in General
4-5. Notes and Chords; Grace Notes and Grace Chords
6 Rests
7. Barlines, Measure Numbers, and Rehearsal Marks
8 Clefs
9. Key Signatures
10. Time Signatures
11-13. Groups: Tuplets; Beams; Octave Signs
14. Tempo Markings
15. Text Strings and Lyrics
16. Dynamics
17. Slurs, Ties, and Horizontal Brackets
18. Staves and Staff Brackets
19. Notation for Chords
20. Endings
21-22. Miscellaneous Graphic Elements, Performance Elements
23. Requirements for Schenkerian Notation

We distinguish three levels of importance: Required, Very Desirable, Desirable. Table 1, extracted from Category 4, gives an idea of the level of detail provided in the document.

5. Conclusions

We sent version 1.0 of "Music Representation Requirement Specification for *Variations2"* to a number of music-representation developers in mid-2002, asking them how well their representations fit our requirements. We received detailed responses from two, and interest from a number of others. Version 1.1 is now on our web site [10]; we have continued to work on the specification since then, and we plan to make further improvements public.

Table 1. An excerpt from the requirements specification.

No.	*LPGA*	*Level*	*Description*
4.8	L	Required	Supports accidentals double-flat thru double-sharp, plus none.
		Desirable	Supports triple-flats and -sharps. (While very rare, these have appeared in published music and could be useful in pedagogy or music-theory work.)
4.9	L	Very Des.	Supports microtonal accidentals, especially quarter-tones.
4.10	G	Required	Supports normal and small-sized accidentals.
		Very Des.	Also supports natural/flat and natural/sharp.

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7. References

[1] AMNS Nightingale. http://www.ngale.com.

[2] Byrd, D. 1984. *Music Notation by Computer* (doctoral dissertation, Indiana University). UMI, Ann Arbor, Michigan (order no. 8506091).

[3] Byrd, D. 2003. Extremes of Conventional Music Notation. http://mypage.iu.edu/~donbyrd/CMNExtremes.htm.

[4] Dannenberg, R. 1993. Music Representation Issues, Techniques, and Systems. *Computer Music Journal* 17(3): 20–30.

[5] Hewlett, W., & Selfridge-Field, E., eds. 2001. *The Virtual Score: Representation, Retrieval, Restoration (Computing in Musicology* 12). Cambridge, Mass.: MIT Press.

[6] Maxwell, John Turner, III & Ornstein, Severo M. 1984. "Mockingbird: AComposer's Amanuensis." *Byte* 9(1): 384-401.

[7] Powell, S. 2002. *Music Engraving Today: The Art and Practice of Digital Notesetting*. New York: Brichtmark.

[8] Read, G. 1969. *Music Notation*. 2nd ed. Boston: Crescendo.

[9] Sloan, D. 1997. HyTime and Standard Music Description Language: A Document-Description Approach. In Selfridge-Field, E., ed. 1997. *Beyond MIDI: The Handbook of Musical Codes*. Cambridge, Mass.: MIT Press, 469–490.

[10] Variations2: IU Digital Music Library Project. http://variations2.indiana.edu/.

[11] Wiggins, G., Miranda, E., Smaill, A., and Harris, M. 1993. A Framework for the Evaluation of Music Representation Systems. *Computer Music Journal* 17,3, 31–42.