Studying Music is Difficult and Important:
Challenges of Music Knowledge Representation

—*or,*

Writing Poetry About Music is Like Dancing About Architecture

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Abstract

In my view, music is one of the most complex, difficult to study, and important to study of all cultural phenomena—in fact, among the most complex, difficult, and important of any phenomena whatsoever. Six features of music make it so: (1) Music is an art, so many musicians try to use its elements in interesting and original ways, not standardized and ordinary ways. (2) Music is a *performing* art, so we have both symbolic representations (both scores and transcriptions of performances) and performances. (3) Much music, especially Western, has synchronization requirements of a complexity equalled in no presentation of information for human consumption we are aware of. (4) Music is often combined with text, so its challenges are in most ways a superset of the problems of text. (5) Music involves many different instruments. This opens up the possibility of versions of a given work for other ensembles or at other levels of technical demands. (6) Music is extremely popular, so, for many works, numerous versions actually exist.

For all these reasons, music is uniquely difficult to deal with, and uniquely valuable to study, especially by computer. To support the argument, we give examples in the form of conventional Western music notation that violate the supposed rules of music notation and/or bring up difficult issues of music representation.

Introduction

In my view, music is one of the most complex and difficult to study of all cultural phenomena—in fact, among the most complex and difficult to study of any phenomena whatsoever. However, most of its difficulties are more extreme instances of difficulties found in other areas. Therefore, studying music is particularly important because solving its problems means automatically solving problems of the other areas.[1] To make the point further, I'll first cite some examples of the limits of

[1] I am by no means the first person to make this argument. In the 1980's, Charles Goldfarb and Steve Newcomb reached a similar conclusion (for timing information in particular; see the footnote about them

conventional music notation as a representation, and comment on what a really good encoding of music requires. Then I'll discuss the specific features of music that I believe make it so difficult.

Stretching the Limits of Music Notation

I have discussed challenges and inconsistencies of music notation and representation elsewhere (Byrd 1994; Byrd 2012a; Byrd 2012b). Representational challenges are the more interesting of the two, and I'll cite just a few of them here. All appear in the (online) work 2012b, and all but the first in the 1994 one.

1. An "impossible" rhythm appears in a passage from a Chopin Nocturne (Op. 15 no. 2) in which one notehead is a triplet in one voice, but normal duration in another. For the last note of the measure, both "versions" of the note end at the barline; therefore, in the upstemmed voice, it begins earlier than in the downstemmed one. But surely Chopin didn't intend it to be sounded twice, and pianists never play it that way. How should it be represented? It's not easy to say. "Iimpossible" rhythms like this, where a single notehead that's part of two voices has interpretations in the voices that are inconsistent, aren't as rare as one might think: Julian Hook (2008) lists dozens of examples in the works of Brahms, Chopin, Rachmaninov, etc.

2. The Brahms Capriccio for piano, Op. 76 no. 1, is in 6/8. A dotted half note lasts a full measure of 6 eighths, or 12 16ths; but one passage has a dotted half note that lasts only eleven 16ths. Why? Notating a duration of 11 16ths "correctly" would have required four tied notes, but the fact that the dotted half note actually used really lasts to the end of the measure and no longer is obvious—so obvious that, surely, few people even notice the inconsistency. Clearly, it's written the shorthand way it is to avoid the clutter of four notes and three ties. This notation is much like the well-known "variable dot" of Baroque music: a dot may increase the duration of a note by more or less than the standard amount.

3. A passage from Debussy's *La Danse de Puck* has a clef in mid-air, applying only to the note to its immediate right, while a different clef appears on the staff they belong to. Thus, it's bizarrely obvious that two clefs are simultaneously active on the staff. On the other hand, a subtle way to have two simultaneous clefs on a staff appears in the fourth measure on the lower staff of this excerpt, from Scarbo in Ravel's *Gaspard de la Nuit.* The passage is in 3/8 time, so the bass and treble clefs are both in effect for this entire measure! The obvious reason in these and other cases of two clefs simultaneously active on a staff (in music by Brahms and others, as well as other works of Debussy) is simply to save space by avoiding a third staff.

4. Triple sharps and flats have appeared in print. One example is an F triple-sharp (used as a lower neighbor between two G double-sharps) near the end of the last movement of Reger's Clarinet Sonata, Op. 49 no. 2, piano part (1904; Universal ed.). Of course, MIDI doesn't even distinguish between sharps and flats, a distinction that most classically-trained music probably consider quite important, even if they play an instrument like the piano that doesn't let them make the difference audible. Double-sharps and -flats allow finer distinctions, and triple-sharps and -flats such fine ones that very few people have ever bothered with them; but they exist.

See also my Web page, "Extremes of Conventional Music Notation" (Byrd 2012).

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below), and Newcomb comments (personal communication, 2008) that Sherwin Gooch made such an argument in the late 1970's.

All music notation (CWMN, tablature, ancient Greek, etc.) is for communication from the composer to the (human) performer, or from the transcriber to the (human) score reader. The composer/transcriber wants to say *just the right thing*s—not too much, not too little—to the performer/score reader; that is, after all, a basic principle of all communication.
This leads to a small number of what I call *metarules* of CWMN, of which the most important is "Omit needless symbols" (to maximize readability). A common example is omitting triplet markings that are obvious where a line has measure after measure of the same rhythm involving triplets. But the "right things" to tell a computer are quite different! One reason is that context dependency often helps people, but it almost always makes things harder for computers.

Why Studying Music is Difficult and Important

The following features of music in general make music exceptionally difficult to study. Some of this applies particularly to computer processing of music, but most applies in any situation.

1. **Music is an art.** Therefore the composer/artist can use its elements any way they like—for example, to confound music-IR systems, as the amusing essay "Composing to Subvert Content Retrieval Engines" points out (Collins 2006). Obviously, very few creative musicians have that goal in mind, but a great many—at least in some cultures, including ours— try to use its elements in original and interesting ways, not straightforward and conventional ways. This (among other things) makes content-based retrieval a great deal harder with music than with expository prose, the type of text that text-retrieval systems usually deal with and that music retrieval is usually compared to. Similarly, there is a story that Marc Chagall said, in response to criticism of his drawing by an art critic, "Of course I draw poorly. I *like* to draw poorly." That is, in his art, Chagall had no intention of using the element of drawing the way it was ordinarily used. The story may be apocryphal, but the point is that a creative person can always find original ways to do whatever they do; in fact, that's virtually the definition of creativity.

   One of the implications of this observation is that we should not expect information retrieval of music to be much like retrieval, in the text domain, of prose; it's more like retrieval of poetry, where the denotations of words as given in dictionaries may be less important than their connotations or even their sounds. But this phenomenon applies to many problems of music informatics, and, indeed, to many problems of doing anything at all with music. For example, in Byrd (2012b), I show and briefly discuss some surprising examples of "rule violations" in music notation; some are purely graphical curiosities, but many strike much deeper. And I have commented elsewhere (Byrd 1994) that "It is tempting to assume that the rules of such an elaborate and successful system as CMN [Conventional Music Notation] must be self-consistent. A big problem with this idea is that so many of the 'rules' are, necessarily, very nebulous... But if you try to make every rule as precise as possible, what you get is certainly *not* self-consistent."

   Obvious as it is, the fundamental difference between works of art and otherwise similar creative products that aren't intended as art is often forgotten. One result is the well-known quotation of uncertain origin (it has been attributed to people from Clara Schumann to Frank Zappa), "Writing about music is like dancing about architecture." This is certainly thought-provoking, but it's not a good analogy because writing about music is generally intended primarily to convey information and only secondarily (if at all) as art. For the same reason, the common variation, "Talking about music is like dancing about architecture", is an even worse analogy. Actually, *writing [or talking] about music is like writing [or talking] about architecture.* Of course, this formulation is not too exciting! Using arts throughout, we might put it like this instead: *Writing poetry about music is like dancing about architecture.* This is a more memorable statement, but really interesting only as a response to the misguided original.

2. **Music is fundamentally a performing art.** Therefore *performances*, *symbolic representations of general performances* (scores and performance parts), and *symbolic representations of specific performances* (transcriptions) all exist, and the relationships among them can be extremely subtle (Goodman 1976). (I say music is "fundamentally" a performing art to distinguish it from forms like poetry, which can be performed, i.e., read aloud by one person for the benefit of others, but rarely is.) To borrow terms from mathematics, the mapping is not one-to-one; it's often many-to-many. For one thing, what is the correct or most authoritative version of a musical work? For Western classical music, it's ordinarily a score, but there may be several that are equally authoritative, or it may be a performance—or a set of parts intended for performers. Bach's *B Minor Mass* is a well-known example of the problems (Frans Wiering, personal communication, January 2009; see also the Wikipedia article "Mass in B Minor"). And as you go back in time, the correct interpretation of any written notation gets more and more difficult.[2] For most traditions other than Western classical music, the most authoritative version is almost always a recorded performance, but there may be many performances with equally strong credentials. It's hard to see how one could decide what is the most authoritative version of the folk song *Greensleeves.* (Cf. Goodman 1976 or Talbot 2000.) Even for recent Western classical music, it's by no means unknown for the composer to record a performance that diverges considerably from their own preexisting score.

   The closest text analog of these first two characteristics together is the play, especially the play in verse.

3. **A tremendous amount of music**, especially Western music, has **complex synchronization requirements.** This applies to most popular and radio and TV music as well as to European art-tradition music. To my knowledge, it is not only unique to music among the performing arts and other physical activities of people (sports, etc.), but it may be more demanding than any other presentation of information intended for human consumption.[3]

   The text equivalent is something like explicitly synchronized speeches in plays, which indeed occur. But there is simply no comparison: even the few examples of these (e.g., Churchill 1982) are far less demanding in terms of synchronization than the vast majority of Western music of, say, the 14th century or later. (In some ways, a play in verse is more like a piece of music than one in prose, and plays in verse are an important category. But of course they almost never involve explicit synchronization.) True, circus acrobats, jugglers working together, etc., do feats that require split-second timing, but at nowhere near the rate of musicians—and never, as far as I know, involving as many simultaneous coordinated events.

4. **Music is often combined with text,** not only via singing but also in the cases of narration and background music, plus several types of annotation in music-notation scores. As a result, the problems of handling music are in several ways a superset of the problems of handling text. For example, to use space efficiently, scores of orchestral works routinely show on a page only staves for instruments that actually play on that page; the instrument to play each staff is identified by a label at the left end of the staff ("flute 1", "fagotti 1 e 2", etc.). Therefore, to convert the score to symbolic form, an optical *music* recognition program must first perform optical *character* recognition (OCR) on the label strings.

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[2] Along the same lines, Nina Fales observes (personal communication, November 2008) that "among ethnomusicologists, a commonly recognized reality of fieldwork is that the further in time and distance a particular item of information travels from its source, the less likely it is to communicate its original significance."

[3] While leading an ISO committee working on a "Standard Music Description Language" (ISO/IEC CD 10743) in the 1980's, Charles Goldfarb and Steve Newcomb reached a similar conclusion, and decided to spin off its machinery for describing time (Steve Newcomb, personal communication, August 2009). The result was HyTime, which is now an international standard (ISO/IEC 10744:1992).

5. **Music involves "instruments",** very often in groups. This has several implications. (a) It makes arrangements and transcriptions of a given work possible. Of course, there are many different instruments, and therefore an enormous number of combinations. Enough of them are actually used that the Library of Congress Subject Headings includes hundreds, if not thousands, of entries for different ensembles. (b) Versions of many works exist for players of different skill levels, mostly lower but often—for virtuosi who want to "show off"—higher than the original. (c) Music notation may represent the sounds to be produced or it may represent the actions the performers are to take to produce the sounds. Both are widely used. Conventional Western music notation largely represents sounds, though it has features (e,g., notation of artificial harmonics for string instruments) that represent actions. Tablature for guitar and similar instruments represents the players' actions ("put a finger in *this* position on *that* string").

6. Finally, **music is extremely popular;** in many cultures including ours, it is among the most popular arts. If this were not the case, perhaps other phenomena would be as complex and challenging. But the great popularity of music overall means that really popular works are likely to exist in many recordings and many scores, in arrangements for several different ensembles of instruments, at multiple levels of technical demands on the performers. As a result, music wins the "most challenging" contest hands down. It also means that handling music's challenges is important in itself, even on purely economic grounds.

Implications for Computer Applications to Music

One of my own research interests is computer systems for music. For all the reasons above, it would be surprising if a computer system designed for music *could not* have features of great value to other domains. Of course this does not mean that we should expect every computer system for music actually to be useful in other areas. The trick is to keep general features of the system separate from music-specific features so the former can actually be used in nonmusic contexts, and few systems are designed that way.

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