

Hidden Beyond MIDI's Reach: Feature Extraction and Machine Learning with Rich Symbolic Formats in `music21`

Michael Scott Cuthbert
Music and Theater Arts
M.I.T.
Cambridge, Mass. 02139
cuthbert@mit.edu

Chris Ariza
Music and Theater Arts
M.I.T.
Cambridge, Mass. 02139
ariza@mit.edu

Jose Cabal-Ugaz
M.I.T.
jcabal@mit.edu

Beth Hadley
M.I.T.
bhadley@mit.edu

Neena Parikh
M.I.T.
nsparikh@mit.edu

Abstract

Symbolic Music Information Retrieval (MIR) and MIDI Feature Extraction are so wedded in the field that they are almost considered synonyms for one another. Yet a wealth of data about notational characteristics and hidden, implied notes are inaccessible in MIDI and require richer data formats not supported by existing musical machine learning tools. `music21`'s ability to extract features from richer formats and to bring out hidden information improves the accuracy of symbolic MIR and opens up new repertoires for study.

1. Moving Beyond MIDI for Feature Extraction

Machine learning on music typically depends on extracting salient numeric features (total range in semitones, number of beats in a measure, etc.) from audio or symbolic data. The format of choice for symbolic data is nearly always MIDI (e.g., in the CFP for this conference MIDI stood in for symbolic MIR as a whole). Yet for many applications MIDI is a choice borne more out of necessity than choice. While it remains an essential standard for musical instrument control, MIDI's ability to express the nuances of a musical score is lacking. It does not record differences between enharmonic tones (such as E-flat and D-sharp), it cannot precisely encode microtones (pitch bend objects being notoriously unreliable and not portable), few implementations support lyrics, the difference between an eighth note and a staccato quarter is erased, chord symbols are not supported, and so on. Many formats, in particular MusicXML but also Humdrum and MuseData, go far beyond MIDI's capabilities in these realms, and recent projects have vastly increased the amount of data in these formats (We think particularly of Vladimir Viro's Peachnote project [5] which has OMR converted the majority of the 100,000 scores of IMSLP into MusicXML). The biggest obstacle to moving beyond MIDI has been the lack of feature extraction software that can read these formats and use their added information.

The `music21` project [2] (<http://web.mit.edu/music21>) has recently added feature extraction and machine learning to its generalized open-source, Python-based toolkit for computational musicology. Elsewhere we have introduced the general capabilities of the "features" module [3], here we will briefly describe its specific capabilities in score preprocessing and machine learning that use features of generalized chords and ornaments beyond those found in MIDI.

2. Preprocessing

`music21` currently imports scores from MIDI, MusicXML, Humdrum, abc, MuseData, Noteworthy Composer (nwc.txt), and monophonic audio. It contains support for extracting the pitches implied by leadsheet chord symbols, roman numeral analyses, and figured basses, including realizing the pitches within a certain range and (particularly important for the latter two formats) only choosing voicings that obey traditional contrapuntal rules (e.g., no parallel fifths) [1]. It can also extract pitches from ornaments. Figure 1 shows the difference between a pitch histogram created based on a printed score and one where the figured bass and the ornaments have been transformed into notes.



Figure 1: Pitch class frequency (C-sharp highlighted) before and after realization

3. Feature Extraction

The “features” module not only contains over 3/4s of the features described by the `jSymbolic` toolkit [4], it also 21 features not found in `jSymbolic`, such as using Google to estimate a composer’s popularity, extracting the language of the lyrics, or algorithmically determining the key and its ambiguity. Some of these features, such as `ChordBassMotion`, use chord symbols directly; others, such as `DiminishedSeventhPrevalence`, use pitches obtained in preprocessing to refine the results. `music21` can output the results of feature extraction in CSV, Tab (for Orange), or ARFF (for Weka) formats.

4. Demonstration and Results

Using `music21`, Orange, and 214 MusicXML leadsheets from Wikifonia (wikifonia.org) whose dates we could determine (via the Billboard Top 100) as being either 1950–60 (120) or post 1980 (94). Dividing these into two nearly equal sets we performed Feature Extraction, first with 29 `jSymbolic` features and then with four native `music21` features that use data from the chord symbols and music notation. Using cross validation in Orange, we compared the results of using Bayes, kNN, and tree classification of “old” vs. “new” on each feature set to the majority baseline (i.e., choosing the most common class every time). The baseline classified 56% of the songs correctly. The 29 MIDI-focused `jSymbolic` features had 56% for kNN, 65% for tree, and 62% for Bayes. The four `music21` features outperformed this result on each classifier: kNN 60%, tree 66%, and Bayes 69%. Although none of these results are spectacular, nonetheless, the ease of adding new extractors to `music21` promises significant improvements in the near future.

Acknowledgments and References

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