

Using the Implication/Realization Model for Measuring Melodic Similarity

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Abstract. The concept of melodic similarity has become increasingly relevant in the light of music retrieval and music content processing systems. We propose a new way of measuring melodic similarity, based on analyses of the melody according to the Implication/Realization (I/R) model [7] for melodic structure and cognition. The similarity is assessed as the edit-distance between these I/R analyses. We present some experiments and results, comparing this approach to edit-distance based measures on other melodic representations. We argue that the I/R representation combines some advantages of the other measures, and is a good compromise between concrete and abstract levels of melody representation.

1 Introduction

Computing similarities in sequences of notes is a very general problem with diverse musical applications ranging from music analysis to content-based retrieval. Choosing the appropriate level of representation is a crucial issue and depends on the type of application. For example, in applications such as pattern discovery in musical sequences [1], [3], or style recognition [3], it has been established that melodic comparison requires taking into account not only the individual notes but also the structural information based on music theory and music cognition [9].

Our research interest concerns the development of a CBR system for expressive music processing. In that context (e.g. for retrieval and reuse mechanisms), a well chosen distance measure for melodies is of importance. Some desirable features of such a measure are the ability to distinguish phrases from different musical styles and to recognize phrases that belong to the same song. We propose a new way of assessing melodic similarity, representing the melody as a sequence of I/R structures (conform Narmour's Implication/Realization (I/R) model for melodic structure [7]). The similarity is then assessed by calculating the edit-distance between I/R representations of melodies. We compared this assessment to assessments based on note representations [6], and melodic contour representations [2, 5].

We have found that the discriminatory power of the note level distance measure is much lower than that of the contour and I/R level measures. Also, taking into account interval durations within the contour level measures, tended to decrease the discriminatory power. We argue that the I/R level measure is an appropriate compromise that takes into account rhythmical/temporal information in an implicit way, without losing discriminatory power.



Figure 1. First measures of All of Me, annotated with I/R structures.

2 The Implication/Realization Model

Narmour [7, 8] has proposed a theory of perception and cognition of melodies, the Implication/Realization (I/R) model. According to this model, melodies can be analyzed into melodic structures, that are identified based on principles similar to those of Gestalt theory [4]. Figure 1 shows an I/R analysis of a melodic fragment. The labels of the structures (*P*, and *ID*) denote whether, and in which dimensions (e.g. the direction and size of the melodic interval) the second melodic interval of the structure realizes the implications raised by the first interval. The extent to which structures are *chained* (i.e. share notes), is related to the strength of *closure* at structure boundaries, which is determined by factors like meter, rhythm, and underlying harmony.

3 Experimentation

We compared the behavior of the I/R measure with three more familiar melodic distance measures: an edit-distance for note representations of the melody, one for interval-contour representations (a sequence of numbers representing the number of semitones between each subsequent pair of notes), and one for direction-contour representations (a sequence of $+1, 0, -1$, denoting the sign of the melodic interval between consecutive notes). We used these four distance measures to assess pairwise distances for a number of musical phrases. The comparison was performed using 124 different musical phrases from 40 different jazz songs from the Real Book. The musical phrases have a mean duration of eight bars. Amongst them are jazz ballads like 'How High the Moon' with around 20 notes, many of them with long duration, and Bebop themes like 'Donna Lee' with around 55 notes of short duration. Jazz standards typically contain some phrases that are close variations of each other (e.g. only different beginning or ending) and some that are more distinct. This is why

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