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A HIDDEN MARKOV MODEL OF MELODY IN GREEK CHURCH CHANT

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ABSTRACT

We present a probabilistic model of melodic process in modern Greek church chant. This largely oral tradition often relies on memorization and improvisation skills that are passed on from teacher to student by example, without explicit appeal to rules. The researcher is thus faced with the challenge of inferring the rules of the idiom from a sample corpus of chants. The structure of the rules will point to the mental representation of melody that underlies learning, recall, and improvisation. Our analysis is performed in two stages. In the first stage, a *Hidden Markov Model* (HMM) is trained on the corpus of chants, using a variant of the algorithm developed by Stolcke and Omohundro. As a termination criterion for this training stage, we use Rissanen's *Minimum Description Length* principle. In the second stage, the optimal HMM is analyzed; its states can be interpreted as probabilistic rules that determine the course of melody, given its preceding melodic and textual context. Our findings show that the melody of Greek chant is shaped by textual word stress on a small scale, and by textual syntactic boundaries on a large scale. Moreover, given the pattern of textual word stress and syntactic grouping, the shaping of the melody within a given mode is completely determined by a small number of *phrase parameters*, reflecting melodic choices at key *decision points*. We discuss the relation of our model to earlier cognitive models of melody, especially that of Deutsch and Feroe.

BACKGROUND AND AIMS

We present a probabilistic model of melodic process in modern Greek church chant. This largely oral tradition is particularly relevant to cognitive studies: within the framework of a church service, chant tunes are often performed from memory or improvised; this skill, moreover, relies to a great extent on implicit, internalized knowledge that is passed on from teacher to student by example, without explicit appeal to rules. The researcher is faced with the challenge of inferring the rules of the idiom from a sample corpus of chants. The structure of the rules will point to the mental representation of melody that underlies learning, recall, and improvisation. Quite apart from its contribution to chant studies, our model may shed light on the cognition of melody in general, and may indeed present an interesting case study of a cognition-driven music theoretic model.

MAIN CONTRIBUTION

In the first stage of our analysis, a *Hidden Markov Model* (HMM) is trained on the corpus of chants, using a variant of the algorithm developed by Stolcke and Omohundro.[1] The algorithm starts with a maximal HMM that overfits the data, and proceeds to systematically reduce the model size by merging states, until an optimal compromise is achieved between goodness-of-fit and generalization. As a termination criterion for this training stage, we use Rissanen's *Minimum Description Length* principle.[2] In the second stage, the optimal HMM is analyzed; its states can be interpreted as probabilistic rules that determine the course of melody, given its preceding melodic and textual context.

Our findings show that the melody of Greek chant is shaped by textual word stress on a small scale (*phrase-shaping* rules); and by textual syntactic boundaries on a large scale (*phrase-succession* rules). Phrase-shaping rules come in two types: *pitch-specific* and *intervallic*. Pitch-specific rules typically characterize the melody's formulaic portions; the latter mostly comprise the beginnings and ends of phrases. Intervallic rules shape the non-formulaic portions of the phrases and require the pitch contour to highlight word stress. According to our model, given the pattern of textual word stress and syntactic grouping, the shaping of the melody within a given mode is completely determined by a small number of *phrase parameters*. These parameters reflect melodic choices at key *decision points* that completely determine the course of the melody until the next decision point is reached. Of course, these "decisions" occur mostly unconsciously in performance; but preliminary evidence from protocol reports suggests that chanters are often aware of some decision points in the melody, and use them as "memory posts."

IMPLICATIONS

As the preceding discussion illustrates, the model enables a given chant tune to be represented by much less information than that contained in the individual notes, significantly easing the strain imposed on the chanter's memory. This is particularly important for learning the fixed tunes of the chant tradition. In addition, the improvisation of the free tunes can happen with considerably less real-time effort, as the chanter's attention need only focus on the decision points. In light of these observations, we consider the relation of our model to possible mental representations of melody, pointing to similarities with previous work, especially that of Deutsch and Feroe.[3]

TOPIC AREAS

Computational Models
Ethnomusicology
Melodic Memory

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