Meter Detection From Music Data

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Abstract— **Meter detection is the organisation of the beats of a given musical performance into a repeating structure of trees at the bar level, in which each node represents a single note value. The metrical structure must be properly aligned in phase with the underlying musical performance so that the root of each tree properly aligns with a bar. In this talk, I will introduce a lexicalized probabilistic context free grammar designed for the task, and show that it performs well on a variety of symbolic corpora when compared to existing work. I will also discuss further enhancements that could be made to the model in order to allow it to achieve good results on a wide variety of genres, and allow it to be run on audio data. Finally, I will discuss this work's role in a larger project stressing the importance of symbolic music analysis for future work on Automatic Music Transcription.**

I. LEXICALIZED PROBABILISTIC CONTEXT FREE GRAMMAR

In designing the grammar, we were careful to make as few assumptions as possible so it can be applied to different genres of music directly (assuming that training data is available). It is a standard probabilistic context free grammar (PCFG) where each terminal is also assigned a head based on some property (in this work, note length is used). Strong heads (in this work, those representing longer notes) propagate upwards through the metrical tree. This lexicalization allows the grammar to model rhythmic dependencies rather than assuming independence as in a standard PCFG, and the pattern of strong and weak beats and sub-beats is used to determine the correct metrical structure.

II. EVALUATION

In evaluation, for each of the three levels (sub-beat, beat, and bar) of the guessed metrical tree, if it matches exactly a level of the correct metrical tree, that is counted as a true positive. On the other hand, a clash is counted as a false positive. Additionally, each of the correct metrical tree's levels which were not matched count as a false negative. Precision, recall, and F1 are then computed based on the given true positive, false positive, and false neg- ative values.

For comparison, we created two baseline models: one which always guesses 4/4 time with the first bar starting on the first note, and a simple PCFG with no lexicalization. We also compare against the models proposed by Temperley [3] and De Haas & Volk [1], though the latter is still in progress due to technical difficulties.

In Table 1, we report the results on two corpora: (1) the 48 fugues from the Well-Tempered Clavier, and (2) the 15 Bach Inventions. We used leave-one-out cross-valida- tion within each corpus for training, and the F1 scores reported are averaged throughout each corpus. Evaluation on additional corpora is in progress.

TABLE I. PRELIMINARY RESULTS

Method	*WTC F1*	*Invention F1*
Temperley [3]	0.63	0.58
4/4	0.45	0.58
PCFG	0.64	0.61
LPCFG	**0.83**	**0.65**

III. Conclusion

The proposed grammar shows promise in time signature detection, and it is clear that lexicalization helps. Future work will investigate the use of different lexical heads; for example, whether using note pitch in the heads would improve performance. We will also adapt the grammar to run on audio data. There are a couple of different options for how to do this: for one, an off-the-shelf onset detection model could be used to convert the audio into a symbolic format (since we do not require note pitch); alternatively, the lexicalized heads could be adapted to draw their strengths directly from the audio data based on some feature extraction.

This work is part of a larger project on using symbolic music analysis to improve automatic music transcription (AMT), and I will briefly discuss how this grammar, modeled jointly with a previously designed voice separation model [2] and other future components, might be adapted to be used alongside existing AMT models, as well as models for other music information retrieval tasks.

REFERENCES

[1] De Haas, Bas W., & Volk, A. (2016). Meter Detection in Symbolic Music Using Inner Metric Analysis. In *Proceedings of the 17th International Society for Music Information Retrieval Conference*, pp. 441–447.

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