Neural network uses harmonic analysis to predict composer of a piece of music

Sjoerd Versteegh

Aim of project

The aim of this project is to investigate to what extent a neural network, based on a harmonic analysis of a composition, can predict the composer of a piece of classical music (Bach, Beethoven and Monteverdi). I expect that harmonic analyses are characteristic for a composer and therefore suitable for predicting which composer wrote a piece.

In previous research, entire MIDI files were provided as input to an algorithm to predict composers of pieces of music (Hontanilla et al., 2013; Kong et al., 2020). The same aim was achieved by analysing a couple of specific aspects and processing these into a classification of the expected composer (Cuthbert et al., 2011; Herremans et al., 2015), and audio recordings have also been used as input (Micchi, 2018). In this study, a new step will be taken: harmonic analyses have not previously been used to recognise composers.

Materials and methods

A piece of music can be reduced into a series of chords. In a harmonic analysis, the sequence of chords relative to the key is noted. My hypothesis was that composers can be distinguished from each other by analysing their chord sequences as a result of their style influencing the chord sequences in a characteristic manner. In this study, a collection of harmonic analyses from Gotham et al. (2019) is used, from which a total of 135 harmonic analyses of pieces composed by Bach, Beethoven and Monteverdi were randomly selected.

The harmonic analyses were presented to a neural network. Neural networks are algorithms capable of recognising patterns in the data provided in a manner comparable to how the brain does that. This type of problem requires a special type of network that considers the order in which the chords are presented. Two frequently used algorithms that are suitable for this are the long short-term memory (LSTM) and the gated recurrent unit (GRU) network. A GRU network has fewer parameters that need to be trained than an LSTM network, as a result of which it tends generalize better when presented with a small dataset. Both algorithms were tested.

Neural networks receive information in the form of vectors and the harmonic analyses therefore need to be provided in this form. For this, word embeddings are utilized. Chords that are very similar to each other and are used in the same context are placed close together in a 128-dimensional vector space. To train the network, it was given access to 36 harmonic analyses per composer. For validation, 9 other analyses per composer were used.

Observations and conclusions

The GRU model achieved an accuracy of 100.0% on a collection of 27 pieces (9 per composer) that the model had not previously encountered. All 27 pieces were therefore correctly classified as composed by Bach, Beethoven or Monteverdi. The accuracy of the LSTM network was not as high, namely 89.0%.

The approach of using harmonic analyses works excellent. It should, however, be noted that 100% accuracy is only an indication of how well the model performs on this small collection of randomly selected pieces. To my knowledge, these results surpass the success rates of previous research into predicting composers using algorithms. The results of this study reveal that harmonic analyses provide sufficient information to predict composers.

References

Cuthbert, M. S., Ariza, C., & Friedland, L. (2011). *Ismir,* 387–392. https://web.mit.edu/music21/papers/Cuthbert_Ariza_Friedland_Feature-Extraction_ISMIR_2011.pdf

Gotham, M., Tymoczko, D., & Cuthbert, M. S. (2019). The RomanText Format: A Flexible and Standard Method for Representing Roman Numerial Analyses. *International Society for Music Information Retrieval Conference (ISMIR)*, 20, 123–129. https://doi.org/10.5281/ zenodo.3527756

Herremans, D., Martens, D., & Sörensen, K. (2015). *Computational Music Analysis*, 369–392. https://doi.org/10.1007/978-3-319-25931-4_14

Hontanilla, M., Pérez-Sancho, C., & Iñesta, J. M. (2013). *Pattern Recognition and Image Analysis*, 740–748. https://doi.org/10.1007/978-3-642-38628-2_88

Kong, Q., Choi, K., & Wang, Y. (2020). *arXiv preprint arXiv:2010.14805*. https://arxiv.org/pdf/2010.14805.pdf

Micchi, G. (2018). *International Society for Music Information Retrieval Conference (ISMIR 2018)*. https://hal.archives-ouvertes.fr/hal-01879276/file/2018-ismir-lb-composer.pdf