Score-based style recognition using artificial neural networks.

Abstract

Overview

The original idea was to develop a system for musicological analysis that was capable of assisting in the resolution of issues concerning compositional authenticity. Based on explicit rule-based interrogation of a musical score the system gathers statistical information by way of a data extraction engine, the subsequent neural network implicitly forms an abstract impression of habitual characteristics within the composition. It must not be assumed that this system aims towards the modeling of human musical perception, as it is the author's belief that score-based analyses cannot adequately meet this task.

Initially the system was developed to explore the authenticity of flute compositions attributed to Frederick II "The Great". Since there has long been musicological debate concerning this matter it was decided to acquire information from both performers of period instruments and musicologists concerning the characteristics and signatures required in the discrimination task. Based on free and multiple-choice reports returned a rule base was compiled that was then implemented into the system.

Methodology

For the purpose of this study it was decided to create a corpus of score representations in ALMA[1], an antiquated and relatively forgotten format. The primary reason for this was the ease of coding without the necessity to sacrifice any of the printed score attributes. Since the system is based on intervallic difference of note relations it was not necessary to transpose the selected material to a common key-signature, which appears to be common practice in similar studies.

Aside from the standard frequency of note distribution statistics, horizontal pitch-class "snapshots" are used in order to obtain a rough image of the tonal contents of each measure. Other data is collected from functions stemming from Lerdahl & Jackendoff (1983) theories on tonal music. In a similar manner vertical pitch-class analysis is employed, this method involves the weighting of individual events based on their metric position to obtain a single vector. Weighting of importance of the vertical pitch-class data is crucial for the perceived tonality of each measure (Cook 2000). Strong-weak interplay between parts provides major individualistic cues in the identification process. Auxiliary and passing notes in this instance are not considered since the resolution is restricted to minimal values of 16th notes.

Efforts to locate modulations were developed by monitoring the frequency of note occurrence over time. Having established the initial key a scan is run over the score to track any deviation, which is assumed if recurring accidental tones match "expected" modulatory practices. For example when a piece initially established as being in C-major displays a recurring F# it is highly likely that a modulation to the dominant key of G-major has occurred.

The sequence recognition algorithm involves the staggered parsing of a back-to-back pair of arrays checking sequences of intervals on the major metric points of the melody. Their function is to identify recurring interval sequences; chromatic, diatonic or pentatonic. The sequences being sought must be concurrent. Motivic interplay as yet cannot be detected.

[1] ALMA was developed by Murray J. Gould, as a successor of the "Plaine and Easie Code" (Gould 1963).

Vector responses from the data extraction engine is fed into a neural network based on Kohonen's (1996) Self-organizing map algorithm (SOM). In the learning cycle 30 compositions of known origin were supplied to the SOM with identification tags. The tested material was similar in nature, style and structure – i.e. Common-time allegro movements from flute compositions by Frederick II, C.P.E. Bach and J.Quantz.

The testing cycle involved the passing of a further 6 compositions (2 by each composer) through the system. In order to obtain a correlative estimate of the system's response, both musicologists and period performers were questioned as to whom they thought composed these additional works.

Results

Having successfully learnt the required corpus the test material was presented to the system. The resulting map showed that the compositions of Frederick, Quantz and Bach were located in three distinctive regions, thus confirming the initial hypothesis that statistical data is sufficient in the identification of individual musical characteristics. It is interesting to note that the works of Frederick II were more closely located to those of Quantz to those of C.P.E. Bach. Thus supporting historical speculation concerning musical allegiances (Helm 1969, Kiernan 1997).

Comparing the results obtained from all sources, it was found that the system's accuracy exceeds that of the human participant, thus prompting the continued development of such an application.

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Suggested Readings

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