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STUDI E TESTI 1

SECONDO CONVEGNO EUROPEO DI ANALISI MUSICALE

ATTI A CURA DI
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I limiti di quanto ipotizzato sono quelli derivati non solo dal fatto che questa situazione si riscontra raramente nelle serie numeriche (almeno in modo altrettanto rigoroso, come nell'esempio) e che solo parziale è stata la ricostruzione delle innumerevoli combinazioni del gioco; altri limiti sono, a nostro avviso, imposti dai principi costruttivi propri dello stile classico. Infatti, se brani a contenuto omogeneo di materiali di base —come suggerisce Rosen— sono indicatori dei princìpi costruttivi preferiti dal tardo barocco, la diversa articolazione di elementi costitutivi (ad esempio una successione $a + b$) della frase musicale è propria dell'età di Mozart e di Haydn. In ciò risiede quindi anche il limite per una assoluta identificazione delle composizioni alla propria matrice, costituita dall'unità micro formale dell'*incipit*.

Della maggiore ricchezza in Haydn si è detto; ma è forse dalla semplicità degli elementi costitutivi del gioco di Mozart che è facile riscontrare una maggior aderenza alle possibilità compositive offerte dall'alea. La caratteristica di queste unità microformali, a prima vista prive di interesse musicale, è che per il loro contenuto *neutro* esse si rendono disponibili per un maggior controllo delle possibilità combinatorie.

A CONNECTIONIST APPROACH TO TIMING DEVIATION CONTROL IN MUSICAL PERFORMANCE

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In the past few years, research in artificial intelligence has increased substantially, both in symbolic and sub-symbolic applications. In particular, many efforts have been made in artificial neural network model development. Unlike other approaches, these networks do not have any previous knowledge base; they are just like a *tabula rasa*, which will be later taught with appropriate examples.

Today, the most utilized neural networks are software simulations of the neural connections in the human brain and since they show an intrinsic non-linearity, they are quite suitable to the solution of complex problems such as rules or concept teaching.

Therefore, we thought about facing the problem of score performance using a connectionistic approach in order to take advantage of its properties.

It is common knowledge that performed music differs from written music because of the action of the performer, who translates the musical text into sounds following performing rules which are historically consolidated and stylistically coherent.

The performer also takes other liberties which are derived from his personal choices. These choices give more emphasis or outline some characteristics of the musical text.

Therefore, it is possible to create a musical performing method that considers various elements which provide the correct translation of musical text into sounds.

Various authors have faced the problem of musical score performance. The first approach was an experimental one: it consisted in the measurement of parametric variations of famous pianists' performances and it tried to interpret

these data [REPP 1990]. Another approach, the analysis-by-synthesis method, consisted in the formulation of some performing rules and verified them through an estimation of their application. This approach was followed mainly at the KTH in Stockholm [SUNDBERG et al. 1991; FRIBERG 1991].

We confronted this problem [DE POLI et al. 1990] and proposed the use of a multilevel knowledge base system to formalize performance rules, and we discussed how to obtain this knowledge base.

The present work has been oriented to the neural network use of solving the problem of score performance. We had intended to follow the direction which integrates and compares the symbolic and the sub-symbolic approaches in order to obtain more natural performances. Among the various aspects of musical performance, timing variation is one of great interest because it is universal to all instruments, can be measured without much difficulty, and it is a crucial aspect of performance.

We used a hybrid system to teach the computer some of the performing rules that had been proposed by Sundberg and his co-workers. With our approach we taught the neural network some meaningful examples (sub-symbolic rules), and we directly applied the simplest rules (symbolic rules). We used a neural net with supervised learning through the error back-propagation method. We chose some parameters, as net inputs, avaible after the original score pre-processing, and also chose the single note time deviation as net output .

We taught many neural nets: one of them was trained with the performance obtained applying Sundberg's rules to the score. Other nets were taught using performances of professional pianists.

The positive results of this research confirm the initial hypothesis on the effectiveness of the use of artificial neural nets in the musical performance. It is important to outline that the nets built in this research allow a real time performance for every score, which is obtained giving in input to the net some fundamental parameters.

These parameters are the nominal duration of the note, its nominal intensity, and its position in the score. This procedure is new when compared to the previous approaches of computer performance. These approaches consist in either a "manual" adjustment of the performing paramenters of each note, or in the use of an expert system that sets these parameters through symbolic rules. There are two basic differences between the performance with neural nets and the above mentioned methods: the first difference is that performance takes place in real time, once the values of duration, intensity, and position of each note are known; the second difference is that the net's training is independent of the

context. For example, music of Mozart and Beethoven can be performed without distinction.

An important result is the possibility of allowing the neural net to perform any score in real time and with the same style, that had been previously taught to the net in a few minutes. The score is performed instantaneously while it is read by the input neurones.

The most important application of the present work is the performance of computer generated music because the computer is not able to set, without any "human help", the time, intensity, and timbre deviations, which are distinctive characteristics of the performers' ability. In this direction, a possible use of our system is the automatic performance of computer generated scores. In this case, the computer automatically introduces both duration and intensity micro-deviations in order to obtain a melodious performance.

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