Doctoral Consortium Research Summary: Virtuosity in Computational Performance

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Abstract. This is a research summary of Virtuosity in Computational Performance, addressing the question: *How can a computer, as judged by a human audience, demonstrate virtuosity in computational performances with a physical model of a bass guitar?* The proposed plan for this research is to develop a computational performance system which uses case-based reasoning and reflection to produce virtuosic performances with a physical model of an electric bass guitar. Three supporting studies are planned to investigate bass playing, collect performance data and perceptions of virtuosity.

Keywords: Computational Performance, Virtuosity, Case-based Reasoning, Reflection, Physical Modelling, Music Analysis

1 The Problem being Addressed and Research Questions

The main question this research is addressing is:

> *How can a computer, as judged by a human audience, demonstrate virtuosity in computational performances with a physical model of a bass guitar?*

Computationally performed music, where a computer is responsible for rendering, generating or synthesising the music in its entirety, can appear lacking, robotic or sterile [1]. There are approaches to overcome this that focus on introducing or emulating expressive phrasing within a performance of a score [1]. However, if instead of expression virtuosity was exhibited within a computer performance, would this not offer a more satisfying solution to sterile performances as well as aiding in investigations into virtuosity of human performances?

Virtuosity here is being viewed as a property of a performance, formed through a complex and dynamic relationship between the performer, an audience and the domain in which the performance is situated [2]. It encompasses notions of expression and style within the performance alongside a demonstration of high levels of technical proficiency, a deeper understanding of the instrument, the piece being played and the context or domain of the performance.

The decision to limit the scope of this research to the domain of electric bass has been made as the author is an experienced electric bass player. There is also recent research [3, 4] within this area that can be used within this PhD.

2 Proposed Plan for Research

To address the main research question, this research will focus on developing a theory for how a computer can exhibit virtuosity within a rendered performance. To allow this theory to be tested a computer performance system that can create performances, using the physical model of electric bass guitar developed by Kramer et al. [3], is planned to be developed.

The current theory is based upon a case-based reasoning approach. Previous work on the SaxEx system [5] has demonstrated how effective case-based reasoning can be when applied to creating expressive performances. Unlike the SaxEx system, which manipulates the waveforms of a non-expressive audio recording as its output, the planned system will be manipulating physical model parameters. These parameters are intended to be abstracted to allow for rationalisation of the performances and evaluation of their virtuosity.

A performance here is being formalised in Equation 1 as the result of $Player$ applying a set of $Techniques$, $\{T_{pluck}, T_{thumb}...T_n\}$, to a sequence of $Notes$, $\langle N_1, N_2...Nn\rangle$. Musical score information, physical model and performance parameters are needed to be represented, abstracted and manipulated to produce a performance. All this information will be represented using the Common Hierarchical Abstract Representation for Music (CHARM) [7, 8].

$$Performance = Player(Techniques, Notes) \tag{1}$$

Cases are to be CHARM constituents. Constituents are formed by grouping together particles. Particles can be either events and/or other constituents. An event differs from a constituent in that it is the most fundamental element of interest within the data and as such cannot be formed from groupings. Constituents enable the formation of hierarchical structures, denoting increases in both hierarchical level and in abstraction. Events form the lowest levels of this hierarchy and within this research will be musical notes. A visual representation of an example is constituent is shown in Figure 1.

When producing a new performance, or interpreting one, a new CHARM representation will need to be constructed. First, constituents of suitable types are found, or created, and then searches for similar constituents are made. A constituent's similarity is to be judged on its structural and musical type, along with the combination and type of its particles. Retrieved constituents can the be modified by interchanging particles for better matching ones to increase the suitability of the constituent for the new case. This process of finding new constituents, then modifying them is akin to the engagement reflection cycle outlined by Pérez y Pérez [6], and is important as being able to reflect upon the performances the system creates can help to guide it towards producing virtuosic one.

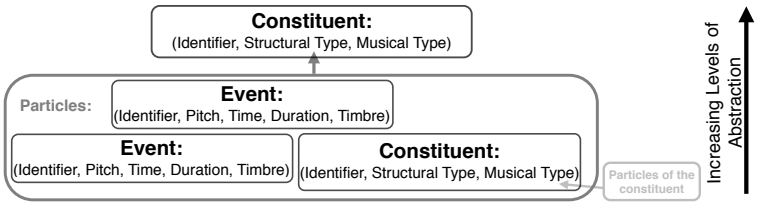

Fig. 1. A visual representation of a CHARM constituent formed of a group of three particles: two events and a constituent, (which has its own particles). I refer the reader to Smaill et al. [7] for more details on the internal structure of event and constituents.

Ontologies for domain specific knowledge e.g. musical score structure, bass technique etc. will be separate from the CHARM representation forming add-on modules for the system. To further inform the knowledge required by the system three studies are planned. One to investigate aspects of bass playing, one to collect performance data and third to see how virtuosity is perceived to inform the reflection of the system.

3 Description of Progress to date

At present I am approaching the first year review of my PhD. The work so far has been in better understanding the form the PhD will be taking, with this document forming a brief summary of the work that has been completed so far.

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References

1. Widmer, G. and Goebl, W. Computational models of expressive music performance: The state of the art. JNMR, 33(3):203-216. (2004)
2. Howard, V. A.: Charm and speed: virtuosity in the performing arts. Peter Lang Publishing Inc., New York. (2008)
3. Kramer, P., Abesser, J., Dittmar, C., and Schuller, G.: A digitalwaveguide model of the electric bass guitar including different playing techniques. ICASSP, IEEE (2012)
4. Abeßer, J.: Automatic Transcription of Bass Guitar Tracks applied for Music Genre Classification and Sound Synthesis. PhD thesis, Elektrotechnik und Informationstechnik der Technischen Universität Ilmenau (2014)
5. Arcos, J. L., Mántaras, R. L., and Serra, X.: Saxex: a case-based reasoning system for generating expressive musical performances. JNMR, 27(3):194-210. (1998)
6. Pérez y Pérez, R.,. MEXICA: A Computer Model of Creativity in Writing. PhD thesis, The University Of Sussex. (1999)
7. Smaill, A., Wiggins, G., and Harris, M.: Hierarchical music representation for composition and analysis. CHum. (1993)
8. Wiggins, G., Miranda, E., Smaill, A., and Harris, M.:A framework for the evaluation of music representation systems. CMJ, 17(3):31-42. (1993)