

## **Review: Computational Models of Expressive Music Performance**

Gerhard Widmer and Werner Goebel review four computational models for automatic music performance in their paper entitled, “Computational Models of Expressive Music Performance: The State of the Art.” A comprehensive analysis of principles, assumptions, and empirical evaluations of the Director Musices system, the Todd model, the Mazzola model, and their own model helps to reveal the state of the art in this field. Although these four models constitute the bulk of the material under investigation, the authors also supply an analysis of older work done by such researchers as Manfred Clynes and E.F. Clarke. I found that the “implicit” model based on analogies and case-based reasoning developed by Lopez de Mantaras to be intriguing, but unfortunately no details are presented in this paper.

The KTH model relies on an additive system of performance rules that are the result of more than 20 years of research at the Royal Institute of Technology in Stockholm. Produced by an analysis-by-synthesis approach, the rules can be turned on and off by a quantity control parameter,  $k$ . As the authors argue, however, the validity and usefulness of each rule’s control parameter value has not been examined well, since it is adjusted for each experiment involving a different composition or performance set. Nonetheless, the model can be used as a “description language” for expression in performance.

In contrast to the KTH model, Neil Todd’s model was developed using only analysis-by-measurement techniques. As we studied in class, the Todd model uses a simple “the faster, the louder” rule for relating timing and dynamics, and the timing is determined directly from the musical structure boundaries. Todd’s model has been found to be over-simplified in terms of describing the timing and dynamics relationship.

A highly mathematical model, Guerino Mazzola’s model incorporates a vast set of music theoretical, philosophical, semiotic, and aesthetic concepts. Widmer and Goebel report that very few empirical analyses of Mazzola’s model have been reported, and without accurate descriptions of each computational tool (e.g. visualization), it is very difficult to perform a substantial evaluation of the model.

The so-called machine learning model developed by the authors and their research group in Vienna is discussed at length in this paper. Their model is actually composed of “note-level” and multi-level” models that help explain expressive music performance characteristics at different time resolutions, e.g. notes, motifs, groups, and phrases. Interestingly, the rules learned resemble those of the KTH model and, as the authors suggest, may provide “further circumstantial evidence for the relevance and validity of the KTH model.”

An area of current research for the authors’ research group is characterization of differences between performers. As expected, differences have been found to be more apparent at lower levels of the structural hierarchy. For visualization and characterization of these individual stylistic preferences, the authors turned to performance trajectories (tempo-loudness contours) and performance alphabets (the centers of normalized clusters of tempo-loudness contours obtained from performance data), respectively. In addition,

the authors present a bit of work done on automatic identification of performers. Their results suggesting that the high-level performance contour information can actually be useful for distinguishing one performer's expressive devices versus another's.

The analysis in this paper is substantial and well-informed. The authors have clearly done a bit of research work in this area, and their work always seems to have momentum; future directions and possibilities are constantly presented. They also stay aware of the somewhat problematic premise underlying their work: performance context, artistic intentions, personal experiences, and listener's expectations all play a role in the human phenomenon of expression. These may simply be considered uncharted waters, however, and may thus govern the course of research to come.