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Synopsis and Response Report of Exploring Expressive Performance Trajectories: Six Famous Pianists Play Six Chopin Pieces by Werner Goebel, Elias Pampalk, and Gerhard Widmer

This paper explores the similarities and differences of expressive performance through the visualization of two-dimensional tempo-loudness. The tempo-loudness data are derived semi-automatically from audio recordings, performed by six famous pianists for six complete pieces by Chopin. The two-dimensional data are segmented according to musical phrases, normalized, and smoothed for comparison. A clustering technique called aligned self-organizing maps is then applied to extract the similarities and differences between those performances, explaining each pianist's performing strategies.

The objective of this study is to unravel expressive principles of particular performers or expressive constraints of certain phrases determined by the score or by convention. The analyzed data are audio recordings of three Nocturnes and three Preludes by Chopin, played by six well-known pianists: Claudio Arrau, Vladimir Ashkenazy, Adam Harasiewicz, Maria João Pires, Maurizio Pollini, and Artur Schnabel. The tempo information is generated by using an automatic beat-tracking tool (Dixon 2001) with manual correction. An overall loudness is calculated for each detected onset. The six pieces are dissected into small segments of one to two bars length, according to their musical phrase structure.

Because the length of performance varies, data is further normalized and smoothed before clustering. The normalization is conducted at three levels: no normalization at the first, subtracting by the mean at the second, and dividing by the mean at the third level. Five smoothing options are provided, including none smoothing, and smoothing windows corresponding to mean performed durations of 0.5, 0.75, 1 or 2 beats respectively. A weighting function to portion tempo and loudness data is mentioned yet not explained in detail. The whole data set is input to the aligned self-organizing maps algorithm (Pampalk 2003). On the map, all elements of a data cluster that are similar to each other are displayed and similar clusters are located close to each other. All the results are shown in a GUI program, allowing users to adjust parameters as well as the ways to represent the trajectories and cluster map of the segmented tempo-loudness data.

Using the results obtained by this technique, the authors are able to compare and analyze performance strategies in detail. They observe the differences and similarities from the cluster map, explaining the strategies in musical terms (ex. *accelerando*, *ritardando*) by mapping the trajectories with their musical perception. The most striking observation is the antagonistic expressive strategies of Pires and Pollini. At the end of the paper, the authors discuss four shortcomings of their approach. First, only overall loudness is measured from the sound.

Secondly, performance information is determined at a defined (fixed) track level, which may disregard potentially important events. Thirdly, the technique contains measure errors. At last, data interpolation for comparison destroys the integrity of the trajectory.

Analyzing performance style among famous performers is the most common application for the tempo-loudness visualization, although it is not a trivial or easy task. The authors adhere to the assumption that performance style is inherent in tempo and loudness dynamics, so that comparing the trajectories can extract the differences between styles. In this paper, the authors track the dynamics at bar level and compare the dynamics in the phrase level with only a few bars and most of the reported examples are two bars only. This kind of low level analysis can only reveal local performance strategies. Global performance strategies will lead too complex trajectories to be analyzed.

The automation of the technique is another problem. Not only the tempo-loudness information is not generated automatically, but also the result comparisons depend too heavily on human. The cluster map only gives a fuzzy feeling about how similar or different the performances are; how and why the performances differ still require human interpretation. One possible way to make the analysis automatic without human interpretation is to first classify trajectories into certain categories of musical dynamics, such as using a convex trajectory or a peak/turning point to represent a ritardando. Once the system learns these examples, the system may be able to report the results in terms of musical patterns. This method is not error free but may shorten the process and increase the amount of analyzes.