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YQX Plays Chopin

Introduction to Expressive Music Performance

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1 Introduction

Listen to the following two performances of Frèderic Chopin's "Nocturnes":

https://www.jku.at/en/institute-of-computational-perception/about-us/people/gerhard-widmer

The first performance from minute 1.55 - 2.08 by a computer just playing the notes of the score. The second performance, minute 2.45 - 3.04 is done by a human. The difference of these two performances is well to hear: the first sounds mechanically and boring whereas the second is expressive [2].

But what does *expressive* mean in this context?

Note: In this presentation the focus is on classical music.

2 Art of Expressive Music Performance

Human musicians do not play a piece of music exactly as written in the printed score, mechanically with constant tempo or loudness. They vary important parameters like dynamics, tempo and so on. At some places they speed up or slow down. The most important parameter dimensions especially for pianists are timing and continuous tempo changes, dynamics (loudness variations) and articulation, which is the way successive notes are connected. These parameters are not specified in the written score, but they are essential for the music to be effective and engaging. These nuances are what an artist makes special and even famous.

Expressive music performance is a creative act. Different artists have endless possibilities of variation and ways of looking at a masterpiece. The music appears in totally different light. But is this freedom unlimited? Not really, because there are specific performance traditions and expections of the audience, although both change over time. A general agreement of the central function of expressive playing is to clarify, emphasize or disambiguate the structure of a piece of music hence the audience hears a particular reading of the music.

Expressive variation is more than *deviation* or *distortion* of the original notated piece of music, it is kind of opposite: The score is the basis of the actual music and the artist is the central role to make the piece *alive*.

3 What Is YQX and How Does It Work

YQX is a computer program developed by Sebastian Flossmann and Maarten Grachten who were researchers in the team of Gerhard Widmer in 2008 at Johannes Kepler University Linz. YQX performed two pieces of classical music that it has never seen before in an *expressive* way *human* or *musical* and won all three Awards of the Rencon 2008 contest: the votes of participants, technical point of view and entrant that affected the set of piece composer (at this contest: Prof. Murao) most. [3]

YQX is based on machine learning. It follows a simple Bayesian model that is trained on a corpus of human piano performances. The objective is to learn to predict three expressive dimensions:

- timing: ratio of the played as compared to the notated time between two successive notes in the score, which indicates either acceleration or slowing down
- dynamics: the relative loudness to be applied to the current note
- articulation: ratio of how long a note is held as compared to the note durations prescribed by the score

For each melody note several properties are calculated from the score (features) and performance (targets). In Fig.1 an example of the features and targets that are computed for a given note (a) and the structure of the Bayesian model (b) is shown.

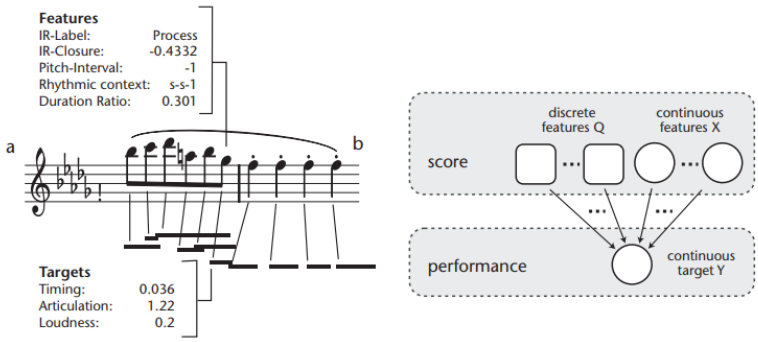

Abbildung 1: Example for one note

The melody segment is from Chopin's Nucturne Op.9, No.1, performed by Nikita Magaloff [4]. The bars below the melody notes indicate the performance, the vertical position pitch and horizontal dimension time). The notated features and targets are calculated for the sixth note and its corresponding performance note. The features are calculated from the note itself and its two neighbors.

The Bayes net is a simple condional Gaussian model. The features are divided into sets of discrete (Q) and continuous (X) features. The continuous are modeled as Gaussian distributions $p(x_i)$, the discrete features through probability tables $P(q_i)$. The target variables Y depend on the score features (Q) and (X). This dependency is given by conditional probability distributions $p(y_i|Q, X)$.

Separately for each target variable, the model is trained by estimating multinomial distributions representing the joint probabilities $p(y_i, X)$. To model the dependency on the dicrete variables Q is done by computing a separate model for each possible combination of the discrete values. This is possible because a very large amount of training data exists. The actual predictions y_i' are approximated through linear regression.

4 Visualization

Expressive timing represented in the phase-plane has advantages compared to the time series representation: Horizontal axis is tempo in beats per minute (bpm), the vertical axis is the first derivative of tempo (amount of accelerando and ritardando). The change of tempo from one time point to the other, which is the derivative of tempo, is represented explicitly as a dimension. There is a variety of notions of change of tempo in music. This makes the phase-plane suitable for visualizing expressive timing. Musicians use patterns of timing and expressive gestures to demarcate musical units, which become nested forms. Fig.?? shows the difference of the possible representations for change of tempo.

Dots in (a) are measured tempo values and the phase-plane trajectories are obtained by approximating them by a spline function. The phase-plane trajectory reveals either finer details or more global trends of the tempo curve.

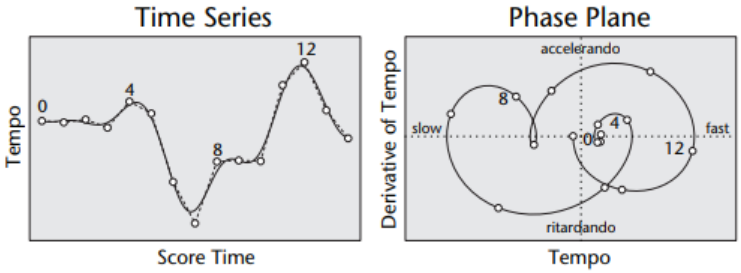

Abbildung 2: Fragment of a tempo curve and the corresponding phase-plane trajectory

5 Creativity of YQX

The question is how is creativity defined. Generally creativity is seen as intentionality, a conscious awareness of form, structure, aesthetics, it is imagination, skill and the ability of self-evaluation. YQX has no notion of concepts like structure, form, repetition or parallelism. It isn't aware of the phrase structure of the piece.

6 Conclusion

State-of-the-art systems like YQX can produce expressive music themselves but neither high-class nor very creative. AI can help study creative behaviors like expressive music performance or artifacts that result from such creative behaviors. That might be interesting for aspects of *rulelike* or *normbased* but also spaces of artistic freedom where artists can develop their personal style.

Carlos Eduardo Cancino Chacón plays Brahm's "Hungarian Dance No.5 in F# minor", a 4 hands version.
https://www.youtube.com/watch?v=Wtxcqp-sQ_4

Literatur

[1] Widmer, G., Flossmann, S., Grachten, M. (2009). *YQX Plays Chopin.* AI Magazine, 30(3), 35. *https://doi.org/10.1609/aimag.v30i3.2249*

[2] *https://www.jku.at/en/institute-of-computational-perception/about-us/people/gerhard-widmer.* (reached at 08.01.2023)

[3] *http://renconmusic.org/.* (reached at 08.01.2023, in maintenance).

[4] *https://en.wikipedia.org/wiki/Nikita_Magaloff.* (reached at 08.01.2023)