

Modeling the Determinants of the Rhythm Type of Classical Piano Playing Based on Mathematical Model Selection

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Keywords: rhythm type; model selection; piano performance; rhythm type influencing factors; Bayesian model

Abstract: In classical piano performance, it is a common practice to classify the rhythmic lines in the phrases. Many musicians have made different assumptions about the selection factors of the rhythmic lines in the phrases in musicology. These hypotheses usually focus on two kinds of factors: the attributes of the phrase itself and the temporal relationship of rhythm changes. Four Bayesian model hypotheses are used for comparative testing to reveal the determinants of the rhythmic line types in classical piano performance. Three models are based on relative entropy, cross-entropy and cross-entropy ratio developed by the author. The combined model, which considers the selection of single rhythm type and the candidate Bayesian diagram model related to both the rhythm type and the position of the sentence in the preface, can more accurately reflect the influencing factors of choosing rhythm type for the sentence in the course of classical piano performance.

1. Introduction

Because there are many factors affecting the rhythm change in performance, this paper abstracts the player's choice of rhythm type in the performance process into two general factors: the attributes of the phrase itself and the rhythm type in the preface phrase, and establishes different Bayesian model with different hypotheses, then chooses the rhythm type by the method of mathematical model selection. The shadows were tested. The two rhythmic determinants selected in this paper are based on the results of many existing musicological studies. There are not a few studies on rhythmic determinants or rhythmic changes in a particular phrase. According to the recordings already made by piano players, the computer associates the music score with the corresponding rhythmic changes. When the computer is a non-learner, it is necessary for the computer to be a non-learner. When expressive rhythm changes occur in the synthesis of synthesized phrases, the most similar phrases that have been learned will be found, and then the learned experience will be used to treat the expressive rhythm changes in the synthesis of synthesized phrases. Therefore, according to the existing literature, the characteristics of the phrases themselves can influence the choice of rhythm patterns.

2. Model Construction and Verification

In the database used in this paper, information about rhythm changes is recorded in the way each beat occurs at the time of performance. In this paper, the rate at which the rhythm is played per unit of time and the unit of music on the score. According to this definition, if a piece of music has a total of “t+1” beats, and each beat occurs at the time of $\{t_1, t_2, \dots, t_{n+1}\}$. The rhythm I can be expressed as $t_i = 1 / (t_{i+1} - t_i)$. Therefore, we can get the rhythm change of a piece on each beat as $\{t_1, t_2, \dots, t_n\}$. Because in the database selected in this paper, the phrases of each piece of music are equal in length in the repertoire. If each phrase in the music has w beat, we can use vector $T_{i=\{t_i, t_{i+1} \dots t_{i+w}\}}$ to represent the rhythm change in a phrase. Using the expectation maximization method, we get that the rhythm change T_i in each phrase in the database should conform to the Gauss mixture distribution with A components, i.e.:

$$p(\mathbf{T}_i) = \sum_{a=1}^A \pi_a N(\tau_i | \mu_a, \Sigma_a)$$

According to the observation of rhythm transformation diagram and the reference to the existing research results, we have developed four candidate Bayesian models: 1) independent model: the choice of rhythm pattern is independent of the position of the sentence and the rhythm pattern of the preface; 2) position model: the choice of rhythm pattern of the sentence is only related to the position of the sentence; 3) timing model; Type A: The selection of rhythmic patterns of musical sentences is only related to the rhythmic patterns of preface sentences; 4) Joint model: The selection of rhythmic patterns of musical sentences is related to both the position of musical sentences and the rhythmic patterns of preface sentences. Variables in each ellipse are regarded as a random variable, and arrows indicate the dependence of random variables, i.e., if A_B, then B events. The probability distribution is influenced by the probability distribution of A events. For the analyzed phrases, the rhythm type is recorded as rhythm type 2; the rhythm type used in the preface phrases of the analyzed phrases is recorded as rhythm type 1. According to the definition of Bayesian model, the above four candidate Bayesian models can be expressed as the position of the phrases and the phrases. The joint probability distribution of the rhythm type used in the preface phrases. Because the relationship between the random variables assumed in the candidate Bayesian graph model is different, we can obtain different joint probability distributions by different methods, that is, according to the independent model, the location model and the time series model, the joint probability distribution can be written as follows:

$$p_{PM}(\text{position}, \mathbf{T}_{i-1}^*, \mathbf{T}_i^*) = p(\text{position}) \times p(\mathbf{T}_{i-1}^*) \times p(\mathbf{T}_i^*),$$

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Because the three random variables in the joint model are correlated, the joint distribution P cannot be expanded and can only be obtained by counting method. It is especially important to emphasize that in some phrases, some specific rhythmic sequences have not appeared, resulting in zero points in the joint probability distribution. These zeros will lead to the "zero probability" problem when verifying the performance of the model, i.e., the probability is zero. Event entropy is infinite. To avoid “zero probability problem”, we use Bayesian probability estimation method to add a minimum probability value to these zero probability points. For example, if the value of x 1 sample in X sample is 1, then the probability $p(X=1)$ of $X=1$ is estimated as follows:

$$p(X=1) = \frac{x_1 + \frac{1}{X}}{X+1},$$

In this piece of music, the data robustness of the time series model is stronger than that of the position model because of the large number of training data points contained in its single performance. By synthesizing the performance of the candidate model, we can find that the robustness of the time series model is not as strong as that of the independent model and the position model, but according to its excellent model performance, we think that the time series model has extremely good data. The time-limited Bayesian model can be used as a rhythm prediction model to replace the joint model with higher complexity.

3. Conclusion

This paper investigates the potential factors affecting the selection of rhythmic patterns of each phrase in classical piano performance. The experimental results show that the selection of rhythmic patterns of each phrase in classical piano performance is influenced by the rhythmic sequence, and the influence of the attributes of the phrase itself on the rhythmic pattern of the phrase should be superimposed on the rhythmic sequence. If it is an independent factor, the attributes of the phrase itself should be superimposed on the rhythmic sequence. The choice of rhythm type in performance is relatively limited.

References

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