

DIFFICULTY ANALYSIS OF ETUDE PIECES CONSIDERING THE COMPLEXITY OF THE ACTION FOR GUITAR LEARNERS

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ABSTRACT

This paper describes the difficulty of classical guitar etudes to support learners' music selection. We first analyzed the complexity of guitar renditions using the Guitar Rendition Ontology (GRO), which is a structural description of the actual actions of techniques. Then, we attempted to calculate the difficulty level of each etude by conducting a new analysis using TF-IDF and the complexity indicator. Experimental results suggested that the difficulty value of an etude corresponds to the author's subjectivity and intention.

1. INTRODUCTION

In learning an instrument performance, the music selected is an important factor. If learners can figure out which techniques they are good or bad at and choose pieces appropriately, they can improve their performance. Especially, etudes are empirically selected and ordered by authors. There are no quantitative indicators at present. We need to clarify the difficulty of each etude to determine what makes it difficult in the first place and what factors contribute to this difficulty. In this study, we focus on the actual actions of specific classical guitar techniques.

We have been developing a domain ontology called the Guitar Rendition Ontology (GRO) [5]. GRO structurally describes the actual actions of a classical guitar techniques for sharing information and learning the guitar. These descriptions can be used to provide valid information on music for selecting music.

There are several approaches related to music selection. One of them is music recommendation, and many systems have been designed by using neural network [4], deep learning [3], emotion recognition [7], and so on. Regarding the classical guitar, [6] analyzed guitar pieces from the perspective of information entropy and provided an indicator to support music selection. The situation we are trying

to support in this study is that of an instrumental player selecting a piece of music. We thus need to take into account information related to movement that could represent the difficulty of the actual performance.

2. ACTION COMPLEXITY OF THE GUITAR RENDITION

The calculation rules of the complexity in each guitar rendition using the GRO version 3.0¹ are as follows. (1) Action related properties such as "action(n)" and "conditional-action(n)" are weighted of 1. (2) Detailed properties such as "direction" and "place of action" are additionally weighted. (3) The player's actions such as "pluck string" are weighted on a scale of 0 to 3.

Figure 1 shows the complexity value of each rendition represented. The range of values is from a complexity of 1 to 16. *Turn with left hand*, a subclass of the *Ornament rendition*, showed the highest value 16, and other renditions in the same category also tended to map high values. In comparison, the *Fingering rendition* and *Note value rendition* values tended to be low, ranging from the lowest value of 1 for *Al aire* to 8 for *Figuetta*, because this is a basic technique of classical guitar. *Percussive rendition* was also similar, with values ranging from 3 to 8.

The values of *Articulation rendition*, *Chord rendition*, *Pitch change rendition*, and *Timbre rendition*, that are applied techniques, varied. For *Chord rendition*, which requires techniques using multiple strings, *Tremolo* and *Rasgueado* had high values. *Tremolo* is an especially difficult technique that even some professional guitarists are not good at.

From these results, we found that the complexity indicator corresponds generally to the intuitive difficulty of a rendition. Applying these complexity values to musical pieces can be provided an effective indicator for music selection. However, there is a problem with a few of the rendition values. *Full planting* is a simple technique where the fingers are set before plucking, so the value should be lower than that of *Arpeggio*. We will discuss this further towards a more complete complexity calculation that matches the player's intuition.



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¹ <https://github.com/guitar-san/Guitar-Rendition-Ontology>

3. DIFFICULTY OF ETUDES

In regarding to guitar renditions, we think that there are three types of difficulty when playing a musical instrument: (1) Difficulty of the rendition itself, (2) Difficulty with the number of renditions, and (3) Difficulty with the order of the renditions. We considered the complexity value of a rendition (defined as $complexity_{r,e}$) as an indicator of type 1. In addition, we attempted to extract indices related to types 2 and 3 by calculating TF-IDF (Term Frequency Inverse Document Frequency) [10] by focusing on the number of occurrences of a rendition. The TF-IDF value is expressed by the following formulas:

$$TF-IDF = tf_{r,e} \cdot idf_r, \quad tf_{r,e} = \log \frac{n_{r,e}}{\sum_k n_{k,e}} + 1,$$

$$idf_r = \log \frac{|D|}{|\{d : t_r \in d\}|} + 1,$$

where $n_{r,e}$ is the value obtained by weighting $complexity_{r,e}$ to the rendition frequency for an etude f_e , $\sum_k n_{k,e}$ is the total number of renditions (including the weight of $complexity_{r,e}$) in the etude, $|D|$ is the total number of etudes in a corpus, and $\{d : t_i \in d\}$ is the number of etudes that contain at least one rendition. Furthermore, the difficulty level of each etude, which is expressed by $difficulty(e)$, is calculated from the following formula:

$$difficulty(e) = \sum_{k \in e} TF-IDF_{k,e}.$$

In this study, we analyzed five etude books that are famous material that has been used in classical guitar lessons. Figure 2 indicates the difficulty level of each etude number. Although etude 2 was relatively high and etude 1 was low, both of them had a tendency for the difficulty level to increase: $R^2=0.470$ and $R^2=0.276$. Moreover, etude 5 showed the similar tendency of the line as etude 2 ($R^2=0.261$). These three etudes took into account the order in which learners can easily practice [1, 2, 8]. For the etude 3 and 4, we could not determine whether the difficulty level corresponded to the etude number because the graphs remained almost unchanged. In fact, there are no explicit instructions in those two books regarding the order of the pieces [9]. Therefore, we found that our approach was somewhat consistent with the subjectivity and intentions of the author of the etude book.

4. CONCLUSION

In this study, we presented an approach to providing an indicator of the complexity of a guitar rendition and the difficulty of a piece on the basis of the Guitar Rendition Ontology (GRO). We selected the five etude books for classical guitar and calculated the difficulty for each etude by using TF-IDF and complexity indicators. As a result, we found that the etude number in etude books corresponded to the subjective perceived difficulty of the etude author. As a future work, we will analyze more pieces and construct a framework for music selection.

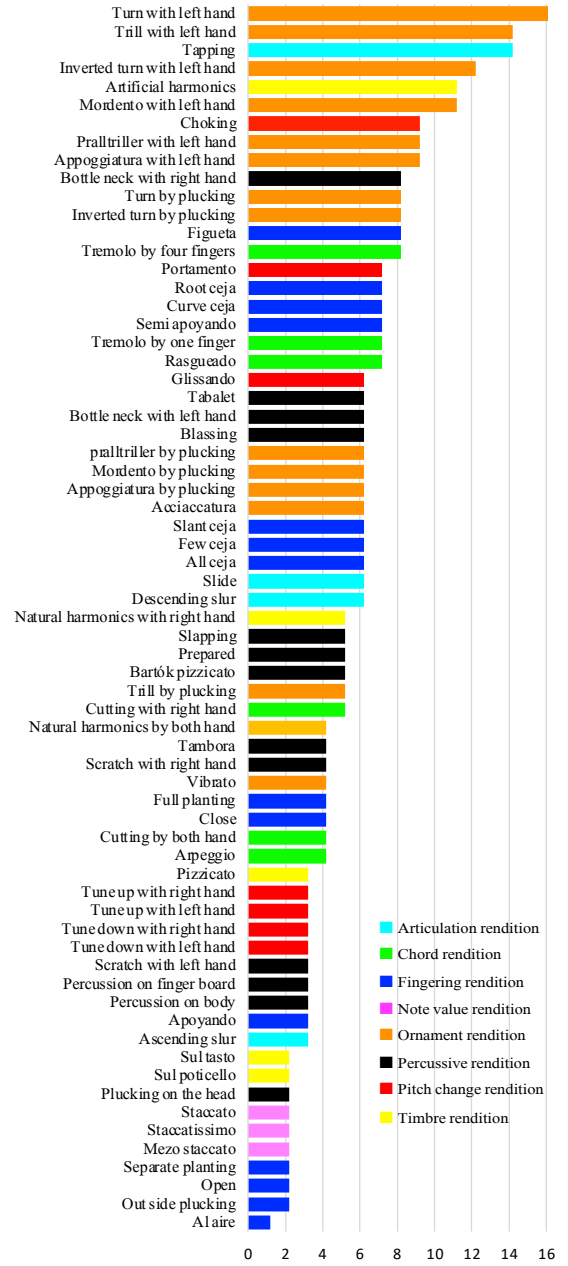


Figure 1. Complexity value of each guitar rendition.

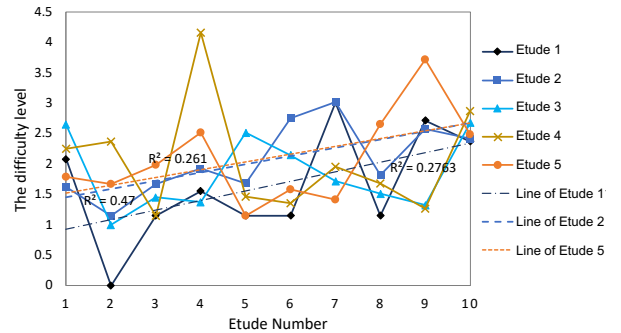


Figure 2. Difficulties of etudes in five books.

5. REFERENCES

- [1] Y. Abe, *Fernando Sor 25 Etudes*, ZEN-ON Music co., Ltd., 1966.
- [2] L. Brouwer, *Guitar Works for guitar solo*, Max Eschig, 2006.
- [3] F. Fessahaye, et al.: T-RECSYS “A Novel Music Recommendation System Using Deep Learning,” *2019 IEEE International Conference on Consumer Electronics (ICCE)*, pp. 1–6, 2019.
- [4] C. Hansen, et al., “Contextual and Sequential User Embeddings for Large-Scale Music Recommendation,” *In Fourteenth ACM Conference on Recommender Systems (RecSys’20)*, Association for Computing Machinery, pp. 3–62, 2020.
- [5] N. Iino, S. Nishimura, T. Nishimura, K. Fukuda, H. Takeda, “The Guitar Rendition Ontology for Teaching and Learning Support,” *The 13th IEEE International Conference on Semantic Computing (ICSC)*, Resource track, Vol. 1, pp. 404–411, 2019.
- [6] N. Iino, Y. Iizuka, S. Okino, Study on Performance Program in Classical Guitar Competitions for Supporting Piece Selection, *IPSJ Journal*, 59(3), pp.904–911, 2018.
- [7] J.M.Z. Maningo et al., A Smart Space with Music Selection Feature Based on Face and Speech Emotion and Expression Recognition, *2020 IEEE REGION 10 CONFERENCE (TENCON)*, pp.696–701, 2020.
- [8] Y. Obara, S. Obara, *25 Estudios Op.60 Matteo Carcassi*, Edition Casa de la Guitarra, No.101, 1965.
- [9] A. Segovia: *Twenty Studies for the guitar by Fernando Sor*, EMI Music Publishing Japan Ltd., 2000.
- [10] W. Zhang, T. Yoshida, X. Tang, A comparative study of TF*IDF, LSI and multi-words for text classification, *Expert Systems with Applications*, Vol.38, No.3, pp. 2758–2765, 2011.