CrestMusePEDB 2nd EDITION: MUSIC PERFORMANCE DATABASE WITH PHRASE INFORMATION

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ABSTRACT

Music performance databases that can be referred to as numerical values play important roles in the research of music interpretation, analysis of expressive performances, automatic transcription, and performance rendering technology. We are creating and will publicly release a new version of the CrestMuse Performance Expression Database (PEDB), which is a performance expression database of more than two hundred virtuoso classical piano performances of scores from the Baroque period through the early 20th century, including music by Bach, Mozart, Beethoven, and Chopin. The CrestMusePEDB has been used by more than 50 research institutions around the world. It has especially contributed to research on performance rendering systems as training data. Responding to the demand to increase the database, we started a three-year project in 2016 to develop a second edition of the CrestMusePEDB. In this second edition, 443 performances that contain quantitative data and phrase information about what the pianists had in mind while playing the performance are also included. We further report on the final stage of the project, which will end next winter.

1. INTRODUCTION

The importance of music databases has been recognized through the progress of music information retrieval technologies and benchmarks. Since 2000, some large-scale music databases have been created and have strongly impacted the global research arena [1–4]. Metatext information, such as the names of composers and musicians, has been attached to large-scale digital databases and used in the analysis of music styles, structures, and performance expressions, from the viewpoint of social filtering in MIR fields.

Performance expression data plays an important role in formulating impressions of music [5–8]. Providing a music performance expression database, especially for describing deviations from a neutral expression, can be regarded as research in the sound and music community (SMC). In spite of there being a lot of music research using music performance data, few projects have dealt with creating a music performance database that is open to the public.

In musicological analysis, some researchers constructed a database for the transition data of pitch and loudness, and then used the database in statistical processing. Widmer *et al.* analyzed deviations in the tempi and dynamics of each beat from Horowitz's piano performances [9]. Sapp *et al.*, working on the Mazurka Project [10], collected as many recordings of Chopin's mazurka performances as possible to analyze deviations in tempi and dynamics by each beat in a similar manner as [9].

We are creating and will publicly release a Performance Expression Database (CrestMusePEDB), which consists of more than 200 virtuoso piano performances of classical music from the Baroque period through the early twentieth century, including music by Bach, Mozart, Beethoven, and Chopin [11]. The first edition of the CrestMusePEDB (ver.1.0-3.1) has been used as musical data by more than 50 research institutions throughout the world. In particular, it has contributed to research on performance rendering systems, which are use it as training data [12, 13].

The database is unique in providing a set of detailed data about expressive performances, including the local tempo for each beat, and the dynamics, onset time deviation, and duration for every note. For example, the performance elements provided in the Mazurka Projects data [10] are only beat-wise local tempi and dynamics. In the MAPS database [14], which is widely used for polyphonic pitch analysis and piano transcription, performance data does not include any temporal deviations, and thus cannot be thought of as realistic performance data in terms of musical expression. Such detailed performance expression data is crucial for constructing performance rendering systems, and is used as realistic performance models for analysis and transcription.

The CrestMusePEDB 1st edition is not large enough, compared with other databases for computer science. Demand for this kind of database has been increasing in recent years, particularly in studies using machine learning techniques. In addition, data that explicitly describes the relationship between a performance and the musical structure intended by the performer has been required [1]. Responding to these demands, we started a three-year project in 2016 to enhance the CrestMusePEDB in a second edition [15]. We report on the final stage of our project which will be finished by next winter.

[1] In many cases, the apex (the most important) note in a phrase is selected by the performer, and there may be a case where phrase sections are analyzed based on the performers own interpretation.

2. PROJECT OVERVIEW

The first edition of the CrestMusePEDB has contributed to the SMC field, especially for performance rendering studies. Current mainstream performance systems refer to the existing performance data. Above all, systems based on recent machine learning techniques require larger corpora. The size of the first edition CrestMusePEDB is not necessarily large compared with other databases publicly for researching natural language processing or speech recognition. Demand for enhancing this database has been recently increasing.

Another expectation imposed on the performance database is the handling of musical structure information. Although virtuoso performances remain in the form of an acoustic signal, it is hard to find material that shows the relationship between a performance and its intended musical structure by the performer. In many cases, we have no choice but to estimate the performers intention from recorded performances.

Responding to these demands, we started a three-year project in 2016 to enhance the database in a second edition with the goals of increasing the data size and providing structural information. One of the major problems with making the first edition was the workload required for manually transcribing performances in an acoustic signal format. To solve this, we re-recorded the performance data using a Yamaha Disklavier with the cooperation of skillful pianists, who have won prizes in piano competitions. This enabled us to obtain music performance control data (MIDI) and acoustic data simultaneously.

3. PROCEDURE FOR MAKING THE DATABASE

3.1 Overview

The main goals of the CrestMusePEDB 2nd edition were to enhance the performance data and provide structural information paired with the performance data. The outline of database generation is shown in Fig. 1. This edition provides: (1) recording files (MIDI and WAV), (2) score files (MusicXML and MIDI), (3) information regarding phrase structure and "apex note" that each of the pianist predicts the ideal listeners would conceive as the most significant note in each phrase, in PDFs and plain text (Fig. 2), and (4) alignment information from the original file format (*matching file* format).

Musical structures differ depending on pianists' interpretations and depending on the score version. Some musical works, e.g., Mozart's famous piano sonata in A Major K. 331, have multiple versions of the scores such as the Henle Verlag, and the Peters Edition.

Before recording, the pianists were asked to prepare to play their most natural interpretation of the score. Further, they were requested to prepare an additional interpretation, such as by a different score edition, as a professional conductor suggests, or by over-expressing the pianists' interpretation. Pianists were requested to express the difference of these multiple interpretations regarding the phrase structure.

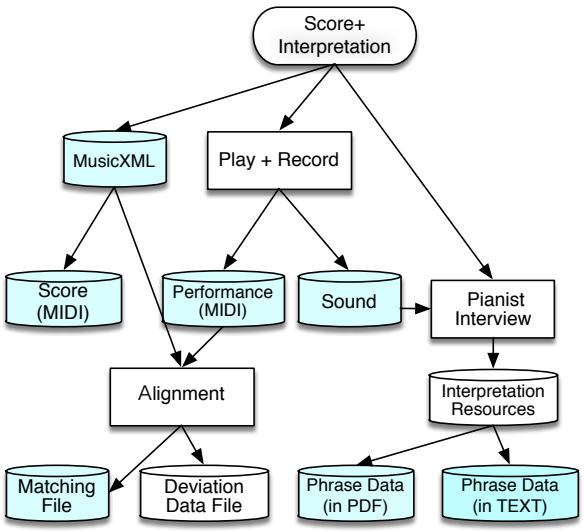
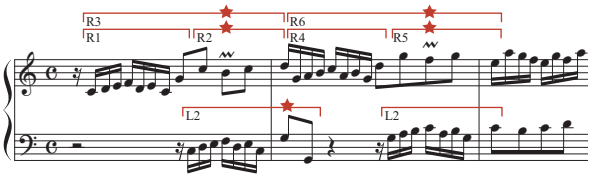


Figure 1. Outline of the database generation. Blue denotes data included in the database.



(a)

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// Perfm: n18-bac-inv001-o-p8_fmt3x.txt
R1; null; [P1-1-2, P1-1-3, P1-1-4, P1-1-5, P1-1-6, P1-1-7, P1-1-8, P1-1-9]
R2; P1-1-11; [P1-1-10, P1-1-11, P1-1-12, P1-2-1]
R3; P1-1-11; R1, R2;
R4; null; [P1-2-2, P1-2-3, P1-2-4, P1-2-5, P1-2-6, P1-2-7, P1-2-8, P1-2-9]
R5; P1-2-11; [P1-2-10, P1-2-11, P1-2-12, P1-3-1]
R6; P1-2-11; R4, R5;
L1; P1-2-13; [P1-1-15, P1-1-16, P1-1-17, P1-1-18, P1-1-19, P1-1-20, P1-1-21, P1-2-13, P1-2-14]
L2; null; [P1-2-17, P1-2-18, P1-2-19, P1-2-20, P1-2-21, P1-2-22, P1-2-23, P1-3-17]
...
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(b)

Figure 2. Sample of phrase data: a) PDF data. Square brackets and star marks denote phrase/sub-phrase and apex (marked with star), respectively; b) Representation of PDF data in plain text format.

After recording, the pianists listened to their recorded performance, and we interviewed them on how they tried to express the intended structure of the piece.

Through these steps, source materials for the database were obtained. Then, the materials were analyzed and converted to data to be referenced in the database. The main procedure in this stage was note-to-note matching between score data and the performance. To improve efficiency for further analysis and utilization of the database, each note in the performance data was given information for the corresponding note in its musical score. For this, a matching file was generated using our original score-performance alignment tool based on an HMM [16] and a visualization tool called *Alignment Editor* (Fig. 3).

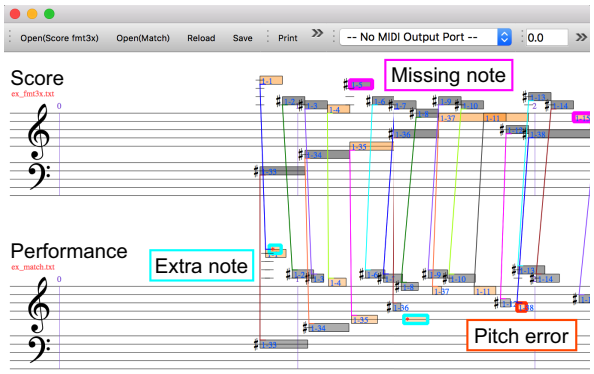


Figure 3. Visualization tool used to obtain the alignment information (see text).

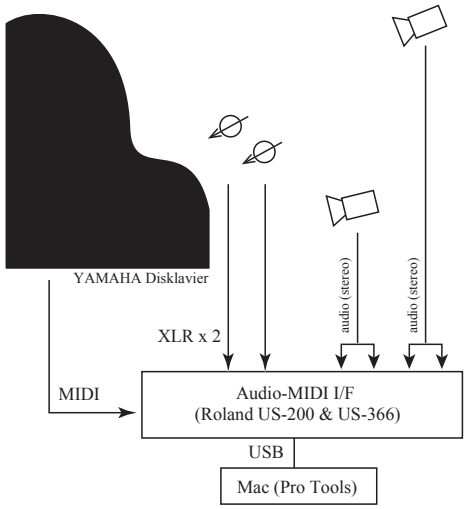


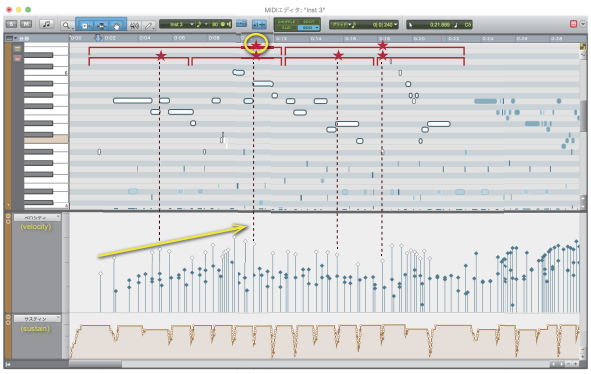
Figure 4. Technical setup for the recording

3.2 Recording

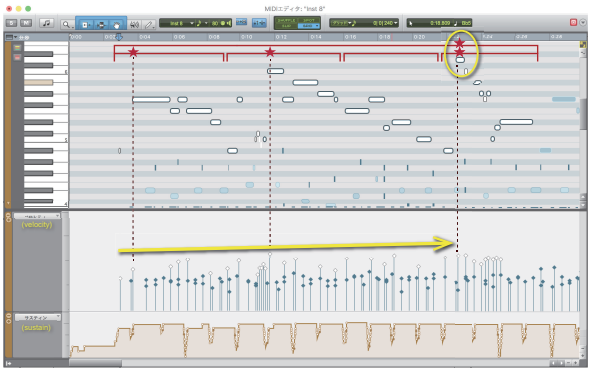
The key feature in the creation of the 2nd edition CrestMusePEDB is that we could talk with the pianists directly about their performances. Before recording, we confirmed with each pianist that the recorded performance should clarify its phrase structure (phrase or sub-phrase) and "apex note", as the "interpretation" of the performance.

Pianists were asked to: (1) play based on their own interpretation for all pieces, and (2) play with exaggerated expressions retaining the phrase structure for some pieces. In addition, for some pieces, pianists were asked to (3) play with the intention of accompanying a soloist or dancers. If there were different interpretations or score editions of one piece, they played both versions. For Mozarts piano sonata in A Major K. 331 and Beethoven's "Pathetique" Sonata, the 2nd movement, different versions of the scores were provided to the pianists.

Recordings were done in several music laboratories or recording studios. As shown in Fig. 4, performances



(a) Performance data of pianist A



(b) Performance data of pianist B

Figure 5. Two pianists' interpretation (phrase structure) and performance data (piano-roll) for part of Chopin's Nocturne in E-flat Major, Op. 9, No. 2.

played with a Yamaha Disklavier were recorded as both audio signals and MIDI data including controls of pedals via Pro Tools. We also recorded video of the interviews afterward.

4. PUBLISHING THE DATABASE

We will have finished recording all the performances by the end of May, 2018. We plan to release the 2nd edition CrestMusePEDB consisting of 443 performances of 24 pieces by 12 professional or contest-winning pianists at the end of September, 2018.

Table 1 shows a list of the scores (35 pieces, some pieces were played with more than one expression or interpretations), which were played by 12 pianists. In this category, nine performances were not able to be recorded due to some pianists preferences in the interpretations. Therefore, there are 411 performances in this category.

In addition, we collected another 32 performances to increase the number of different scores by asking one pianist to play the list shown in Table 2.

Figure 5 shows a sample of performance data for different interpretations by two pianists for part of Chopin's Nocturne in E-flat Major, Op. 9, No. 2. First, we can see that the two pianists interpretations differ in phrase structure: boundary of upper phrases and the positions of apices. From the piano rolls, we can see that pianist A

played faster than pianist B. Regarding the expression of the apex notes (of a higher phrase), pianist A seemed to express the apex notes more saliently than pianist B.

Figure 6 shows another sample of performance data by three pianists for part of Chopin's Etude in E Major, Op. 10, No. 3. Each player marked a different note (x, y, z) as the 'apex' note in the same phrase shown in a bracket. This figure looks like that three pianists expressed crescendo from the beginning part toward note (x). Compared with note (x), pianists C and D maintained the intensity of note (y), and pianist E reduced the intensity of note (y). Major difference of these performances is expression regarding prolongation of the notes (tempo expression). Pianist C and E played their apex note (x) or (z) longer. Pianist C, somewhat, prolonged one 16th note of the accompaniment part, just prior to her/his apex note (x). Pianist D and E prolonged plural 16th notes of the accompaniment part, just prior to her/his apex note (y) or (z). To sum up, this example suggests three pianists played in a same manner; crescendo toward an important note (x) prior or corresponding to each apex note, and prolongation of prior adjacent note(s) to each apex note.

These observations suggested that some part of each control of the expressive performances may be explained from the viewpoint of phrase structure. It was impossible to understand the difference of those performances based only on the identical score. Differences of interpretation by each of pianists intention may be considered evidence to explain the differences in performances. We expect the phrase data will be used to produce more rational performances for systems-based machine learning techniques.

5. CONCLUDING REMARKS

We have introduced our latest attempt to enhance the CrestMusePEDB and provided an overview of the CrestMusePEDB 2nd Edition, which consists of 443 piano performances.

There is no other machine-readable performance database associated with musical structures. We hope that the database will be used for research in many research fields related to music performances. As future work, we would like to conduct performance rendering contests "Rencon" by letting contestants use this enhanced database as a reference dataset for their systems.

Acknowledgments

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Table 1. List of performances included in the 2nd Edition. *self*: the pianist's expression, *over*: over expression, *accomp.*: played as an accompaniment for solo instruments or a chorus, *waltz*: focused on leading a dance, *Hoshina*: played in accordance with a professional conductor's interpretation, *Henle* and *Peters*: used the score of the Henle and Peters Editions, and others: extra expressions via discussion with the authors and the pianist.

No.	Composer	Title	Expression Type [s: self, o: more expressive]	Players											
				P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
1	F. Chopin	Étude Op. 10, No. 3 Tristesse	s	x	x	x	x	x	x	x	x	x	x	x	x
2	F. Chopin	Étude Op. 10, No. 3 Tristesse	o	x		x	x	x	x	x	x	x	x	x	x
3	F. Chopin	Fantaisie-Impromptu in C-sharp minor, Op. posth. 66	s	x	x	x	x	x	x	x	x	x	x	x	x
4	F. Chopin	Fantaisie-Impromptu in C-sharp minor, Op. posth. 66	o	x		x	x	x	x	x	x	x	x	x	x
5	F. Chopin	Nocturne in E-flat major, Op. 9, No. 2	s	x	x	x	x	x	x	x	x	x	x	x	x
6	F. Chopin	Prelude in C major Op. 28, No. 1	s	x		x	x	x	x	x	x	x	x	x	x
7	F. Chopin	Prelude in E minor Op. 28, No. 4	s	x	x	x	x	x	x	x	x	x	x	x	x
8	F. Chopin	Prelude in A major Op. 28, No. 7	s	x	x	x	x	x	x	x	x	x	x	x	x
9	F. Chopin	Prelude in D-flat major Op. 28, No. 15 "Raindrop"	s	x	x	x	x	x	x	x	x	x	x	x	x
10	F. Chopin	Waltz No. 1 (Grande valse brillante in E-flat major, Op. 18)	s	x	x	x	x	x	x	x	x	x	x	x	x
11	F. Chopin	Waltz No. 1 (Grande valse brillante in E-flat major, Op. 18)	as dance accompaniment	x	x	x	x	x	x	x		x	x	x	x
12	F. Chopin	Waltz No. 3 in A minor, Op. 34-2	s	x	x	x	x	x	x	x	x	x	x	x	x
13	F. Chopin	Waltz No. 7 in C-sharp minor, Op. 64-2	s	x	x	x	x	x	x	x	x	x	x	x	x
14	F. Chopin	Waltz No. 7 in C-sharp minor, Op. 64-2	as dance accompaniment	x	x	x	x	x	x	x		x	x	x	x
15	F. Chopin	Waltz No. 9 in A-flat major, Op. 69-1	s	x	x	x	x	x	x	x	x	x	x	x	x
16	F. Chopin	Waltz No. 10 in B minor, Op. 69-2	s	x	x	x	x	x	x	x	x	x	x	x	x
17	J. S. Bach	Invention No. 1	s	x	x	x	x	x	x	x	x	x	x	x	x
18	J. S. Bach	Invention No. 1	o	x	x	x	x	x	x	x	x	x	x	x	x
19	J. S. Bach	Invention No. 2	s	x	x	x	x	x	x	x	x	x	x	x	x
20	J. S. Bach	Invention No. 2	o	x		x	x	x	x	x	x	x	x	x	x
21	J. S. Bach	Invention No. 8	s		x	x	x	x	x	x	x	x	x	x	x
22	J. S. Bach	Invention No. 15	s	x	x	x	x	x	x	x	x	x	x	x	x
23	J. S. Bach	Invention No. 15	o	x		x	x	x	x	x	x	x	x	x	x
24	L. v. Beethoven	Piano Sonata No. 14 "Moonlight", 1st Mov.	s	x	x	x	x	x	x	x	x	x	x	x	x
25	L. v. Beethoven	Piano Sonata No. 8 "Pathetique", 1st Mov.	s	x	x	x	x	x	x	x	x	x	x	x	x
26	L. v. Beethoven	Piano Sonata No. 8 "Pathetique", 2nd Mov.	s	x	x	x	x	x	x	x	x	x	x	x	x
27	L. v. Beethoven	Piano Sonata No. 8 "Pathetique", 2nd Mov.	based on Hoshina's method	x	x	x	x	x	x	x	x	x	x	x	x
28	L. v. Beethoven	Piano Sonata No. 8 "Pathetique", 3rd Mov.	s	x	x	x	x	x	x	x	x	x	x	x	x
29	L. v. Beethoven	Bagatelle No. 25 in A minor "Für Elise"	s	x	x	x	x	x	x	x	x	x	x	x	x
30	L. v. Beethoven	Bagatelle No. 25 in A minor "Für Elise"	o		x	x	x	x	x	x	x	x	x	x	x
31	R. Schumann	Kinderszenen Op. 15 No. 7 "Träumerei"	s	x	x	x	x	x	x	x	x	x	x	x	x
32	W. A. Mozart	Piano Sonata K. 331 Mov. 1	Henle Edition	x	x	x	x	x	x	x	x	x	x	x	x
33	W. A. Mozart	Piano Sonata K. 331 Mov. 1	Peters Edition	x	x	x	x	x	x	x	x	x	x	x	x
34	Japanese folk song	Furusato	s	x	x	x	x	x	x	x	x	x	x	x	x
35	Japanese folk song	Furusato	as accompaniment	x	x	x	x	x	x	x	x	x	x	x	x
		Total:	411	33	30	35	35	35	35	35	33	35	35	35	35

Table 2. List of extra performances played by one pianist

No.	Composer	Title	Expression Type [s: self, o: more expressive]
36	J. S. Bach	Wohltemperierte Klavier 1-1	s
37	J. S. Bach	Wohltemperierte Klavier 1-1	as accompaniment
38	L. v. Beethoven	Piano Sonata No. 14 "Moonlight", 1st Mov.	o
39	F. Chopin	Mazurka No. 5 in B-flat major, Op. 7-1	s
40	F. Chopin	Mazurka No. 13 in A minor, Op. 17-4	s
41	F. Chopin	Mazurka No. 13 in A minor, Op. 17-4	o
42	F. Chopin	Mazurka No. 19 in B minor Op. 30-2	s
43	F. Chopin	Mazurka No. 19 in B minor Op. 30-2	o
44	F. Chopin	Nocturne in E-flat major, Op. 9, No. 2	o
45	F. Chopin	Prelude in C minor Op. 28, No. 20 "Funeral March"	s
46	C. Debussy	Prelude Book 1, No. 8 "La fille aux cheveux de lin"	s
47	C. Debussy	Prelude Book 1, No. 8 "La fille aux cheveux de lin"	o
48	C. Debussy	"Rêverie" L. 68	s
49	E. Elgar	Salut d'amour Op. 12	s
50	E. Elgar	Salut d'amour Op. 12	as accompaniment
51	G. Händel	Ombra mai fù / Largo	s
52	G. Händel	Ombra mai fù / Largo	as accompaniment
53	Japanese folk song	Oboro-zuki-yo	s
54	Japanese folk song	Oboro-zuki-yo	as accompaniment
55	F. Liszt	Liebestraum No. 3	s
56	F. Mompou	Impresiones intimas No. 5 "Pajaro triste"	s
57	W. A. Mozart	Piano Sonata K. 331 Mov. 1	s
58	W. A. Mozart	Twelve Variations on "Ah vous dirai-je, Maman", K. 265/300e, Theme	s
59	W. A. Mozart	Twelve Variations on "Ah vous dirai-je, Maman", K. 265/300e, Theme	o
60	S. Rachmaninov	Prelude in C-sharp minor Op. 3, No. 2	s
61	S. Rachmaninov	Prelude in C-sharp minor Op. 3, No. 2	moderately
62	M. Ravel	Pavane pour une infante défunte	s
63	E. Satie	Gymnopédies No. 2	s
64	E. Satie	Gymnopédies No. 2	moderately
65	R. Schumann	Kinderszenen Op. 15 No. 7 "Träumerei"	moderately
66	P. I. Tchaikovsky	The Seasons Op. 37b No. 6 "June: Barcarolle"	s
67	P. I. Tchaikovsky	The Seasons Op. 37b No. 6 "June: Barcarolle"	o
		Total:	32

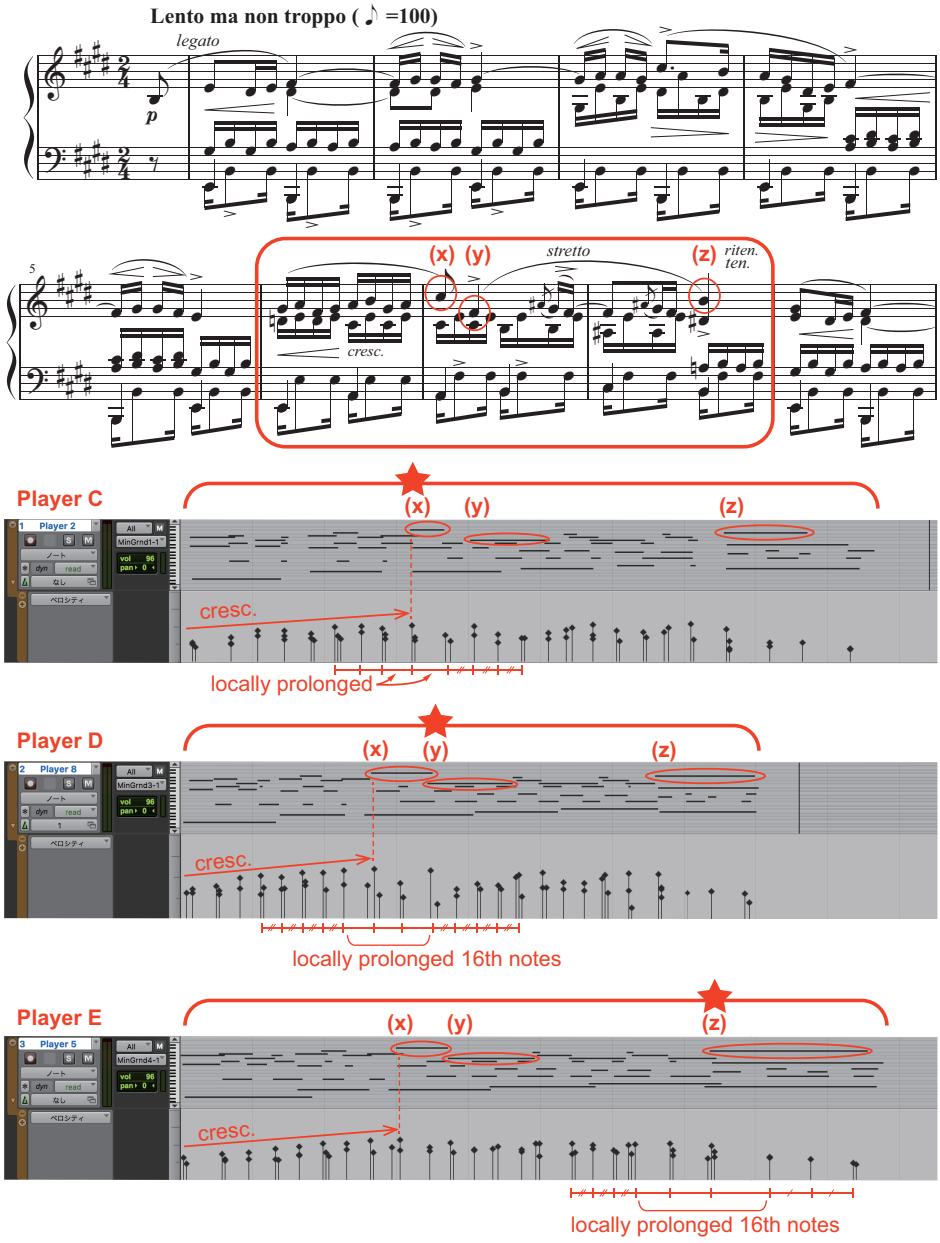

Figure 6. Three pianists' interpretation (phrase structure) and performance data (piano-roll) for part of Chopin's Etude in E Major, Op. 10, No. 3.