A Piano Ballad Arrangement System

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Abstract. This paper presents a system for generating ballad-style arrangements for piano scores of popular music. While other systems for automatically generating piano arrangements exist, most of them have aimed at reproducing the original arrangement as well as possible on the piano only and do not attempt at an arrangement in a style different from the original. Given a new version of a popular song, our technique converts it into a ballad based on the several "ballad arrangement rules" (BAR). We analyzed 100 ballad arrangements from commercial piano books, and designed broken chords and note reduction rules based on BAR. Experimental results demonstrate that our system can enhance ballad-likeness.

Keywords: arrangement, ballad, piano score

1 Introduction

The piano is one of the most popular instruments in the world, and many commercial scores using popular music are sold to hobby pianists[1]. There are two different strategies for piano arrangement. One reproduces the original arrangement on the piano, called a *straight piano piece*: i.e., the piano plays the same chords and rhythms as on different instruments, such as the guitar and bass. This creates familiarity for listeners of the original piece, although phrases on the piano vs. on the guitar (or bass) are fundamentally different. The other is referred to as *varied piano arrangement*, in which the style is changed. Many commercial jazz books or ballad-style pieces with popular songs have been sold[2].

The purpose of this study is to (semi-)automatically convert a straight piano arrangement into a non-straight (ballad-style) piano arrangement. However, this endeavor is still in the process of being refined. While other systems for straight piano arrangement have been developed, as yet there is no system that can convert a straight piano arrangement to into a non-straight one. Takamori et al. generated straight piano arrangements from musical audio signals (Takamori, Nakatsuka, Fukayama, Goto, & Morishima, 2019), while Onuma et al. modeled how professional musicians work with straight piano arrangements (Onuma &

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[1] https://www.ymm.co.jp, https://www.print-gakufu.com

[2] https://www.ymm.co.jp/feature/utsukushiku_piano_solo.php

Hamanaka, 2010). Nakamura et al. introduced a two-handed fingering model to play straight piano arrangements (Nakamura & Sagayama, 2015). Chiu et al. examined each instrument in the original arrangement on the basis of that instrument's role to effectively reduce that part (Chiu, Shan, & Huang, 2009). Other systems working with guitar arrangement use a guitar-fingering model(Tuohy & Potter, 2006; Hori, Kameoka, & Sagayama, 2013).

The main issue in converting straight piano arrangements into ballad-style ones is how to design appropriate conversion rules. In one approach, machine-learning technologies are used to learn conversion rules. However, a parallel dataset (many pairs of straight piano arrangements and ballad styles of the songs) is required. Therefore, in this work we manually designed a ballad arrangement rules (BAR) based on our analysis of ballad-style arrangements made by professional musicians.

2 Ballad Arrangement Rules (BAR) Design

2.1 Ballad-style characteristics analysis

We analyzed the characteristics of a ballad by comparing 94 songs from non-ballad piano books[3] and 100 ballad arrangements from piano books[4]. We focused on the accompaniment for the left hand. Each MIDI file included the accompaniment part, and we analyzed four items: broken chords, chords, note values, and pitch. We dealt with the whole song, the first 24 bars, and the last 24 bars as the intro and ending sections are more unique in their arrangement than the other sections. Non-ballad music included 11,934 bars and a ballad had 8,777 bars in all of the scores.

Broken chords We analyzed broken chords separately as a broken chord type 1 and type 2. For example, the broken chord type 1 contains arpeggio and type 2 contains Alberti bass. The broken chord type 1 satisfies the following constraints Type-1 (1 to 4) and type 2 chord satisfies Type-2 (1 to 5). We dealt with major, minor, seventh, and ninth chords regarding 3 of Type-1 and 4 of Type-2 in each definition.

Type-1
1 All notes are single notes in the range.
2 There are three or more notes in the time direction in the range.
3 All notes are chord tones in the range.
4 Each note is higher than the one that precedes it in the range.

Type-2
1 All notes are single notes in the range.
2 There are four notes in the time direction in the range.

[3] https://yamahamusicdata.jp/
[4] https://www.ymm.co.jp/feature/utsukushiku_piano_solo.php

Table 1. Proportion of the number of bars that applied to broken type 1 and 2 chords.

		Broken chord type 1		Broken chord type 2	
		Non-ballad	Ballad	Non-ballad	Ballad
Whole song	all	0.079	0.240	0.002	0.002
	major	0.062	0.169	0.000	0.001
	minor	0.013	0.053	0.001	0.000
	7th	0.010	0.048	0.000	0.001
	9th	0.012	0.063	0.000	0.000
First 24 bars	all	0.082	0.196	0.003	0.003
	major	0.064	0.128	0.001	0.001
	minor	0.011	0.032	0.002	0.001
	7th	0.012	0.040	0.000	0.002
	9th	0.013	0.056	0.000	0.000
Last 24 bars	all	0.031	0.091	0.000	0.000
	major	0.032	0.048	0.000	0.000
	minor	0.004	0.013	0.000	0.000
	7th	0.007	0.023	0.000	0.000
	9th	0.007	0.036	0.000	0.000

Table 2. Proportion of the number of bars that contain a chord of each note value.

	Whole		First 24 bars		Last 24 bars	
	Non-ballad	Ballad	Non-ballad	Ballad	Non-ballad	Ballad
Whole	0.01	0.02	0.02	0.03	0.01	0.02
Half	0.01	0.10	0.05	0.13	0.02	0.7
Quarter	0.21	0.19	0.21	0.20	0.21	0.20
8th	0.25	0.17	0.06	0.15	0.06	0.15
16th	0.05	0.02	0.07	0.02	0.07	0.02

Table 3. Proportion of the number of bars that contain notes of each note value.

	Whole		First 24 bars		Last 24 bars	
	Non-ballad	Ballad	Non-ballad	Ballad	Non-ballad	Ballad
Whole	0.02	0.04	0.04	0.05	0.01	0.03
Half	0.07	0.20	0.09	0.25	0.09	0.25
Quarter	0.51	0.54	0.53	0.56	0.21	0.24
8th	0.81	0.73	0.75	0.68	0.36	0.29
16th	0.19	0.16	0.23	0.14	0.23	0.14

3 Notes are triad tones in the range.
4 Each note is higher than the one that precedes it in the range.
5 The notes are a series of the lowest one, the highest one, the second lowest one, and the highest one in the range.

We examined the number of bars in the non-ballad music and ballad-style music and we determined that they have broken chords type 1 and type 2, respectively. We considered separately the analysis within the first bar, the half bar up to the second beat, and the half bar after the third beat. We counted those that satisfied all constraints as bars of a broken chord type 1 or a broken chord type 2. Table 1 shows the comparison between the non-ballad music and the ballad music for the broken chords type 1 and type 2. Each result presents the proportion of bars that contain broken chords. However, the total number of bars that include a chord does not always equal the number of bars that include an entire broken chord since there might be multiple variances in a bar. Compared to non-ballad music, the results of the broken chord type 1 showed that the ballad had a higher proportion of bars that included all the broken chords in all the songs. Compared to the first 24 bars, the last 24 bars had a lower proportion of bars that included broken chords. Meanwhile, the proportion of the whole broken chord type 2 was significantly lower than that of the broken chord type 1. Also, there were no bars with a broken chord type 2 in either music in the last 24 bars.

Chord We determined the proportion of the number of bars in the non-ballad music and the ballad music that contained the chords of a whole note, a half note, a quarter note, an eighth note, and a sixteenth note. We regarded a note in which two or more notes began to sound simultaneously as a chord. We considered the

Table 4. Average pitch number of all notes in the accompaniment.

	Whole		First 24 bars		Last 24 bars	
	Non-ballad	Ballad	Non-ballad	Ballad	Non-ballad	Ballad
Average of pitch	48.9	56.1	50.0	57.4	48.0	55.7

note value of the lowest note in the chord tones as the chord's note value. Table 2 shows the proportions of bars that contained the chord values of the non-ballad and ballad music of the whole song, the first 24 bars, and the last 24 bars. The proportion exceeds 1.0 in total since it represents the number of bars that are included. The proportions of the ballad music were clearly higher than those of the non-ballad music in whole notes and half notes. In contrast, the proportions of the quarter note chords were usually higher in the non-ballad music.

Note value We examined the number of bars in the non-ballads music and ballad music that contained the note values of the whole note, half note, quarter note, eighth note, and sixteenth note. Table 3 shows the number of bars with notes of the same note value in the non-ballad music and the ballad music, along with their proportions in the whole song, the first 24 bars, and the last 24 bars. The ballad music clearly had a higher proportion of whole notes and half notes, and the non-ballad music was usually higher than the ballad music in sixteenth notes.

Pitch Table 4 shows the results of our investigation of the average pitch of all the notes in the accompaniment of the non-ballad music and ballad music with a MIDI note number. The average pitch of the ballad music was higher than that of the non-ballad music.

2.2 BAR

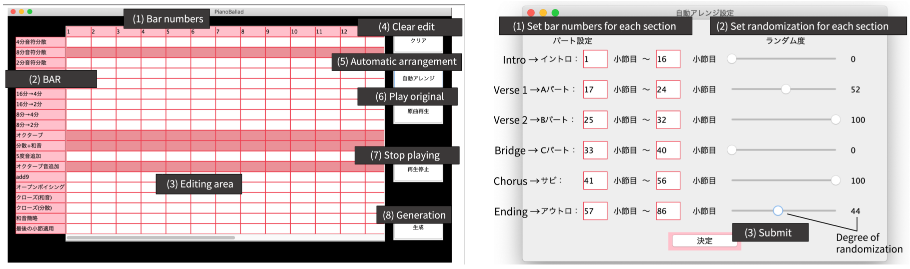
We assume the following characteristics of the piano ballad based on these analyses: it contains many broken type 1 chords and many slow rhythm chords (e.g., whole notes and half notes), it consists of fewer fast rhythm notes (e.g., sixteenth notes), and it contains high-pitched notes. We define BAR in Table 5 on the basis of these characteristics. There are 19 rules categorized into four groups: broken chords, prolonged note value chords, note reduction, and voicing changing.

3 System

Figure 1(a) shows the main screen. A user manually applies a BAR for each bar by clicking cells in the editing area. Our system allows the user to apply multiple BARs to each bar. Then, a ballad-style MIDI file is generated by pushing the generation button (8). The play tempo is set to two-thirds the tempo of the original song. The automatic arrangement button (5) allows the user to make a

Table 5. BAR

	Input	Output	Additional explanation
1	Chord on the first beat	Broken chord type 1 consisting of quarter notes	If the chord consists of five or more notes, this rule does not apply. The notes after the second beat are invalid.
2	Chord on the first beat	Broken chord type 1 consisting of eighth notes	If the chord consists of nine or more notes, this rule does not apply. The notes after the second beat are invalid.
3	Chord on the first beat	Broken chord type 1 consisting of half notes	If the chord consists three or more notes, this rule does not apply. The notes after the second beat are invalid.
4	Chord on the first beat	Whole note chord	The notes after the second beat are invalid.
5	Chord on the first and third beats	Half note chords	If there is a second or fourth chord, it will be valid.
6	Four consecutive sixteenth notes	Quarter notes	The second and subsequent sixteenth notes are invalid.
7	Eight consecutive sixteenth notes	Half note	The second and subsequent sixteenth notes are invalid.
8	Two consecutive eighth notes	Quarter note	The second and subsequent eighth notes are invalid.
9	Four consecutive eighth notes	Half note	The second and subsequent eighth notes are invalid.
10	Every note	Higher-octave notes	The right hand part as well as the left hand part will be an octave higher.
11	Broken chord type 1 or 2	Broken chord with a fifth note	A fifth note is added to the last note of the broken chord.
12	All notes	Each note with fifth notes	
13	All notes	Each note with one-octave notes	
14	Broken chord type 1 or 2	Broken chord type 1 or 2 with a ninth note	A note that is two degrees higher than the root of a broken chord is inserted, located between the root and the next note. This rule is not applied to a chord.
15	Broken chord type 1 or 2	Open voicing chord	The second lowest note of the broken chord is removed. Then, a note that is one octave higher than the deleted note is added to the end of the broken chord. This rule is not applied to a chord.
16	Chord	Close voicing chord	Each note of the chord is transposed into the octave closer to the root note. This rule is not applied to a broken chord.
17	Broken chord type 1 or 2	Close voicing chord	Each note of the chord is transposed into the octave closer to the root note. This rule is not applied to a chord.
18	Chord or broken chord (type 1 or 2)	Notes without the second lowest note	The second lowest note is removed.
19	First note	Broken chord consisting of eighth notes and a chord of the whole note	This rule is applied to the last bar. The broken chord type 1 is composed of eighth notes from the first note.



(a) Main screen. (b) Automatic arrangement settings.

Fig. 1. System screen.

ballad arrangement automatically. Figure 1(b) shows the display for the settings. After entering the start bar and end bar for each intro, verse, bridge, chorus, and ending section (1), the user sets the randomization for each section (2). Randomization indicates the number of bars to which BAR is randomly applied. The higher the scale, the more randomly the rule is applied to many bars. More than one rule can be applied to each bar, but only one rule is applied to a rule that cannot be duplicated. If the randomization degree is zero, the predefined rules are applied to each bar, depending on the section. Specifically, the intro is 3 and 10, verse 1 is 4 and 10, verse 2 is 2, 10 and 13, the bridge is 4 and 10, the chorus is 2, 10, 11 and 13, and the ending is 5 and 10. When the user has finished choosing their settings, they start an automatic arrangement by pressing the submit button (3).

4 Subjective Evaluation by an Expert

4.1 Experimental conditions

We extracted the chorus section from the piano scores. We regarded the original scores as Method 1. Also, we generated ballad scores under four conditions: manual arrangement by assigning rules by an author (Method 2), automatic arrangement with randomization at 0 (Method 3), automatic arrangement with randomization at 50 (Method 4), and automatic arrangement with randomization at 100 (Method 5). Figure 2 shows the example scores generated from the chorus part of "Silhouette[5]." Additional, generated examples and applied BAR lists are available online[6]. We examined the arrangements under these conditions as a set and prepared six sets. The musical scores of each method had the same tempo. The music score was evaluated by an expert with a PhD in music. We also gave her MP3 data generated by MuseScore[7]. She evaluated the scores while

[5] https://www.print-gakufu.com/score/detail/126421/
[6] https://drive.google.com/drive/folders/1pI4I-cI4i56fHYIYtIZFcpJ3WQoHIYtC?usp=sharing
[7] https://musescore.org/

Fig. 2. Examples of generated results. (a) Original score. (b) Assigning rules manually. (c) Arrangement by randomization at 0. (d) Arrangement by randomization at 50 . (e) Arrangement by randomization at 100.

listening to the music on the basis of four metrics: overall playability, naturalness of continuous notes, harmony in the accompaniment, and ballad-likeness. Each item was given a score on a scale of 1 to 10 (1 = bad; 10 = good). We asked her to write any comments she had.

4.2 Results

Table. 6 shows the evaluation results for six sets of musical scores.

Playability Method 2 had the highest score. The expert commented that "they were easy to play because the same accompaniment pattern continued." Methods 4 and 5 scored lower than Methods 1, 2 and 3. The expert commented that Methods 4 and 5 were "difficult to play musically because the harmony was unpleasant." The overall ease of playing seemed to be affected by whether the simplicity of the same accompaniment pattern continued or played in harmony.

Naturalness of continuous notes Method 1 had the highest average score and Method 5 had the lowest. The expert commented that Method 5 had a lot of unnatural continuous chords. Thus, we can assume that the chord progression

Table 6. Evaluation results of the chorus.

	Playability					Naturalness					Harmony					Ballad-likeness				
method	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
score 1	7	7	7	6	3	8	5	6	4	4	9	6	7	4	3	9	6	7	4	3
score 2	7	8	5	3	3	6	6	5	4	2	5	6	6	2	2	5	7	6	4	3
score 3	9	8	7	6	2	7	6	6	6	2	6	6	6	6	3	5	7	7	7	2
score 4	7	8	9	6	5	7	5	7	5	4	6	5	7	4	4	7	6	6	5	5
score 5	7	6	6	5	5	7	6	7	6	5	7	6	7	6	5	6	6	7	6	5
score 6	7	8	5	6	6	8	7	5	5	5	9	7	6	4	5	6	7	6	6	5
average	7.3	**7.5**	6.5	5.3	4.0	7.2	5.9	6.0	5.0	3.7	7.0	6.0	6.5	4.3	3.7	5.8	**6.7**	**6.5**	5.7	3.9
standard deviation	0.8	0.8	1.5	1.2	1.5	2.8	2.4	2.4	2.1	1.9	1.7	0.6	0.5	1.5	1.2	0.8	0.5	0.5	1.0	1.3

in the accompaniment affected continuous notes. Method 5 presumably scored lowest here because the BARs were applied at random and the scores were converted into strange chord progressions.

Harmony in the accompaniment We can see here again that Method 1 had the highest average score and Method 5 had the lowest. Regarding Method 5, the expert commented that "the chord was unpleasant" and "the accompaniment pattern suddenly switched." Therefore, chord progression and switching the accompaniment pattern seemed to affect the disharmony in the accompaniment. However, some scores were low in Method 1. The expert felt that "it was unnatural because the same accompaniment was repeated."

Ballad-likeness Method 2 had the highest average score, and Method 5 had the lowest. The standard deviation for Method 1 was larger than that for Methods 2 and 3, and for some scores, the rating seemed better for Method 1 than 2. Method 2 had a high score, and the expert commented that "The rhythm pattern of the accompaniment seemed to be a ballad." Regarding Method 5, she commented, "The chords were unpleasant, and the accompaniment pattern was too simple." These results suggest that chord progressions and accompaniment patterns also affect the ballad-likeness. The manual arrangement in Method 2 enabled the arrangement to be closer to a ballad by letting the user apply the proposed BARs for each bar. In the case of Method 5, unintended BARs were applied, which caused a sense of incongruity in the chord progression.

5 Conclusion

We proposed a system that converts existing popular piano songs into ballad-style arrangements. Our results showed that the music we generated with the ballad arrangement rules (BAR) enhanced the ballad-likeness. The original scores had the most connections between the naturalness of continuous notes and the harmony of the accompaniment pattern. On the other hand, the manual arrangements and the results given the randomization at 0 had the highest average scores in terms of playability and ballad-likeness. Manual arrangements were more like ballads than the original scores were.

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