CREATING A CORPUS OF JINGJU (BEIJING OPERA) MUSIC AND POSSIBILITIES FOR MELODIC ANALYSIS

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ABSTRACT

Jingju (Beijing opera) is a Chinese traditional performing art form in which theatrical and musical elements are intimately combined. As an oral tradition, its musical dimension is the result of the application of a series of predefined conventions and it offers unique concepts for musicological research. Computational analyses of jingju music are still scarce, and only a few studies have dealt with it from an MIR perspective. In this paper we present the creation of a corpus of jingju music in the framework of the CompMusic project that is formed by audio, editorial metadata, lyrics and scores. We discuss the criteria followed for the acquisition of the data, describe the content of the corpus, and evaluate its suitability for computational and musicological research. We also identify several research problems that can take advantage of this corpus in the context of computational musicology, especially for melodic analysis, and suggest approaches for future work.

1. INTRODUCTION

Jingju (also known as Peking or Beijing opera) is one of the most representative genres of *xiqu*, the Chinese traditional form of performing arts. Just as its name suggests, it consists of a theatrical performance, *xi*, in which the main expressive element is the music, *qu*. Although it has commonalities with theatre and opera, it cannot be fully classified as any of those. In *xiqu* there are not equivalent figures to that of the theatre director or opera composer; instead, the actor is the main agent for creativity and performance. Each of the skills that the actor is expected to master, encompassing poetry, declamation, singing, mime, dance and martial arts, is learned and executed as pre-defined, well established conventions. It is precisely the centrality of the actor and the acting through conventions what make *xiqu* unique. Its musical content is also created by specific sets of such conventions.

Xiqu genres developed as adaptations of the general common principles of the art form to a specific region, especially in terms of dialect and music. The adoption of local dialects was a basic requirement for the intelligibility of the performance by local audiences. The phonetic features of these dialects, including intonation and especially linguistic tones, establish a melodic and rhythmic framework for the singing. The musical material itself derives from local tunes, which is precisely the literal meaning of *qu*. This implies that music in *xiqu* is not an original creation by the actors, but an adaptation of preexisting material. Furthermore, each genre employs also the most representative instruments of the region for accompaniment, conveying the regional filiation also timbrally. These local features are what define each *xiqu* genre's individuality. Jingju is then the regional genre of *xiqu* that formed in Beijing during the 19th Century, achieving one of the highest levels of refinement and complexity.

Despite the uniqueness of this tradition, the interesting aspects for musicological analysis it offers, and its international recognition, jingju music has barely been approached computationally. Most of the few studies of jingju in MIR have focused on its acoustic and timbral characteristics. Zhang and Zhou have drawn on these features for classification of jingju in comparison with other music traditions [18, 19] and other *xiqu* genres [20]. Sundberg et al. have analyzed acoustically the singing of two role-types [14], whilst Tian et al. have extracted timbral features for onset detection of percussion instruments [15]. More recently, Zhang and Wang have integrated domain knowledge for musically meaningful segmentation of jingju arias [21]. Related to melodic analysis, Chen [3] has implemented a computational analysis of jinju music for the characterization of pitch intonation.

The main concepts that define jingju music are *shengqiang*, *banshi* and role-type. As stated previously, the melodic material used in *xiqu* genres is not original, but derived from local tunes. These tunes share common features that allow them to be recognized as pertaining to that specific region, such as usual scale, characteristic timbre, melodic structure, pitch range and tessitura, ornamentation, etc. This set of features is known as *shengqiang*, usually translated into English as 'mode' or 'modal system' [16]. Each *xiqu* genre can use one or more *shengqiang*, and one single *shengqiang* can be shared by different genres. There are two main *shengqiang* in jingju, namely *xipi* and *erhuang* (see Table 2). Their centrality in the genre is such that jingju music as a whole has been also named by the combination of these two terms, *pihuang*.

The melodic features determined by the *shengqiang* are rhythmically rendered through a series of metrical patterns called *banshi*. These *banshi* are individually labelled and defined by a unit of metre, a tempo value and a degree of melodic density; they are associated as well to an expressive function. The system of *banshi* is conceived as derived from an original one, called *yuanban*, so that the rest of them are expansions, reductions or free realizations of the first one [8]. The *banshi* system in jingju consists of a core of eight patterns commonly used, plus some variants.

Each of the characters of a play is assigned to one specific, pre-defined acting class, according to their gender, age, social status, psychological profile and emotional behavior. These acting classes are known as *hangdang* or role-types, and each actor is specialized in the performance of one of them. Each role-type determines the specific set of conventions that must be used for the creation of the character, including those attaining to music. Consequently, *shengqiang* and *banshi* will be expressed differently by each role-type, so that these concepts cannot be studied without referencing each other. In jingju there are four general categories of role-types, with further subdivisions. We consider that the five main role-types regarding musical expression are *sheng* (male characters), *dan* (female characters), *jing* (painted-face), *xiaosheng* (young males), and *laodan* (old females). They are usually classified into two styles of singing, the male style, characterized for using chest voice, used by *sheng*, *jing* and *laodan*, and the female one, sung in falsetto and higher register, used by *dan* and *xiaosheng*.

The fullest expression of such melodic concepts occurs in the singing sections called *changduan*, which can be compared, but not identified, with the concept of aria in Western opera (to ease readability, we will use the term 'aria' throughout the paper). Consequently, we have determined the aria as our main research object, and it has been the main concern for the creation of our corpus and the analyses suggested.

In this paper we present a corpus of jingju music that we have gathered for its computational analysis. We explain the criteria followed for the collection of its different types of data, describe the main features of the corpus and discuss its suitability for research. Thereupon we explore the possibilities that the corpus offers to computational musicology, focusing in melodic analysis, specifically in the concepts of *shengqiang* and role-type.

2. JINGJU MUSIC RESEARCH CORPUS

In order to undertake a computational analysis of jingju music, and to exploit the unique musical concepts of this tradition from an MIR perspective, we have gathered in the CompMusic project a research corpus [12] that includes audio, editorial metadata, lyrics and scores. We introduce here the criteria for the selection of the data, describe its content and offer a general evaluation.

2.1 Criteria for data collection

For the collection of audio recordings, which is the core of the corpus, we have considered three main criteria: repertoire to be covered, sound quality and recording unit. In order to take maximum advantage of the unique features of jingju music, we have gathered recordings of mostly traditional repertoire, as well as some modern compositions based on the traditional methods. The so-called contemporary plays, since they have been created integrating compositional techniques from the Western tradition, have been disregarded for our corpus. Regarding the sound quality needed for a computational analysis, and considering the material to which we have had access, the recordings that best suited our requirements have been commercial CDs released in the last three decades in China. Finally, since our main research object is the aria, we have acquired CDs releases of single arias per track. This means that full play or full scene CDs, and video material in VCD and DVD have not been considered. These CDs have been the source from which we have extracted the editorial metadata contained in the corpus, which have been stored in MusicBrainz.[1] This platform assigns one unique ID to each entity in the corpus, so that they can be easily searchable and retrievable.

Our aim has been to include for each audio recording, whenever possible, its corresponding lyrics and music score. All releases gathered included the lyrics in their leaflets for the arias recorded. However, since they are not usable for computational purposes, we get them from specialized free repositories in the web.[2] As for the scores, an explanation of its function in the tradition is first needed. Since jingju music has been created traditionally by actors, no composers, drawing on pre-existing material, scores appeared only as an aide-mémoire and a tool for preserving the repertoire. Although barely used by professional actors, scores have been widely spread among amateur singers and aficionados, and are a basic resource for musicological research. In fact, in the last decades there has been a remarkable effort to publish thoroughly edited collections of scores. Although many scores are available in the web, they have not been systematically and coherently stored, what makes them not easily retrievable. Furthermore, they consist of image or pdf files, not usable computationally. Consequently, we have acquired printed publications that meet the academic standards of edition, but that will require to be converted into a machine readable format.

2.2 Description of the corpus

The audio data collection of the corpus is formed by 78 releases containing 113 CDs, consisting of collections of single arias per track. Besides these, due to the fact that

[1] http://musicbrainz.org/collection/40d0978b-0796-4734-9fd4-2b3ebe0f664c

[2] Our main sources for lyrics are the websites http://www.jingju.com, http://www.jingju.net and http://www.xikao.com.

many of the consumers of these recordings are amateur singers, many releases contain extra CDs with just the instrumental accompaniment of the arias recorded in the main ones. Consequently, the corpus also contains 19 CDs with just instrumental accompaniments.

Although we do not have complete figures yet, we have computed statistics for different aspects of the corpus. The releases contain recordings by 74 singers, belonging to 7 different role-types, as indicated in Table 1.

Laosheng	20	*Xiaosheng*	9
Jing	7	*Wusheng*	3
Laodan	8	*Chou*	3
Dan	24		

Table 1. Number of singers per role-type in the corpus.

As for the works, the corpus covers 653 arias from 215 different plays. Table 2 shows the distribution of these arias according to role-type and *shengqiang*. Since the number of *banshi* is limited and all of them frequently used, an estimation of its appearance in the corpus is not meaningful. As shown in Table 2, the corpus contains highly representative samples for the research of the two main *shengqiang* and the five main role-types as described in section 1. Table 3 displays more detailed numbers concerning these specific entities. The editorial metadata stored in MusicBrainz include textual information as well as cover art. For the former the original language has been maintained, that is, Chinese in simplified characters, with romanizations in the Pinyin system, stored either as pseudo-releases or aliases.

Role-types	
Laosheng	224
Jing	55
Laodan	66
Dan	257
Xiaosheng	43
Wusheng	3
Chou	5

Shengqiang	
Xipi	324
Erhuang	200
Fan'erhuang	31
Nanbangzi	25
Sipingdiao	23
Others	45
Unknown	5

Table 2. Distribution of the arias in the corpus according to role-type and *shengqiang*.

Regarding the scores, the corpus contains two collections of full play scores [5, 22] and an anthology of selected arias [6]. The two collections contain a total of 155 plays, 26 of which appear in both publications; the anthology contains 86 scores. This material offers scores for 317 arias of the corpus, that is 48.5% of the total.

Apart from the research corpus, but related to it, specific test corpora will be developed, consisting of collections of data used as ground truth for specific research tasks, as defined by Serra [12]. The test corpora created in the framework of the CompMusic project are accessible from the website http://compmusic.upf.edu/datasets. To date there are two test corpora related to the jingju music corpus, namely the *Beijing opera percussion instrument dataset*,[3] which contains 236 audio samples of jingju percussion instruments, used by Tian et al. [15] for onset detection of these instruments, and the *Beijing opera percussion pattern dataset*,[4] formed by 133 audio samples of five jingju percussion patterns, supported by transcriptions both in staff and syllable notations. Srinivasamurthy et al. [13] have used this dataset for the automatic recognition of such patterns in jingju recordings.

2.3 Evaluation of the corpus

For the evaluation of the corpus, we will draw on some of the criteria defined by Serra [12] for the creation of culture specific corpora, specifically coverage and completeness, and discuss as well the usability of the data for computational analyses.

2.3.1. Coverage

Assessing the coverage of the jingu music corpus is not an easy task, since, to the best of our knowledge, there is no reference source that estimates the number of plays in this tradition. However, compared with the number of total plays covered in our collections of full play scores, which are considered to be the most prominent publications in this matter, the number of plays represented in our corpus is considerable higher. Besides, these releases have been purchased in the specialized bookshop located in the National Academy of Chinese Theatre Arts, Beijing, the only institution of higher education in China dedicated exclusively to the training of *xiqu* actors, and one of the most acclaimed ones for jingju. Our corpus contains all the releases available in this bookshop at the time of writing this paper that met the criteria settled in section 2.1. Regarding the musical concepts represented in the corpus, Table 2 shows that both systems of role-type and *shengqiang* are equally fully covered, with unequal proportion according to their relevance in the tradition, as explained in the introduction. As for the *banshi*, as stated previously, they are fully covered due to their limited number and varied use. Consequently, we argue that the coverage of our corpus is highly satisfactory, in terms of variety of repertoire, availability in the market and representation of musical entities.

2.3.2. Completeness

Considering the musicological information needed for each recording according to our purposes, the editorial metadata contained in the releases are fully complete, with the exception of the 5 arias mentioned in Table 2 (0.8% of the total), which lack information about *shengqiang* and *banshi*. One important concept for aficionados of this tradition is the one of *liupai*, or performing schools. However, this concept is far from being well defined, and depends both on the play and on the per-

[3] http://compmusic.upf.edu/bo-perc-dataset
[4] http://compmusic.upf.edu/bopp-dataset

Role-type	Singers	*Xipi*		*Erhuang*		Total	
		Recordings	Duration	Recordings	Duration	Recordings	Duration
Laosheng	18	179	12h 09m 47s	147	13h 30m 51s	326	25h 40m 38s
Jing	6	41	3h 04m 30s	43	3h 21m 39s	84	6h 26m 09s
Laodan	8	30	2h 00m 54s	52	4h 37m 54s	82	6h 38m 48s
Dan	24	224	17h 26m 00s	101	11h 13m 02s	325	28h 39m 02s
Xiaosheng	9	40	3h 19m 00s	7	41m 14s	47	4h 00m 14s
Total	65	514	38h 00m 11s	350	33h 24m 40s	864	71h 24m 51s

Table 3. Data in our corpus for the analysis of the two main *shengqiang* and five main role-types.

former, and usually is not specifically stated in the releases. Finally, the information related to the publication of the recordings is not consistent. Usually, the dates of recording and releasing are not available from the CDs. However, the releasing period has been restricted to the last three decades by our criteria, as stated in section 2.1, although in some rare cases some of these releases may contain recordings from earlier periods.

2.3.3. Usability

The data contained in the corpus are fully suitable for analysis of jingju music according to the musical concepts explained in section 1. However, not all the data are equally usable. The main difficulty is presented by the scores, to date available only in printed edition. Consequently, for their computational exploitation they need to be converted into a machine readable format. In the CompMusic project we intend to use MusicXML, maintaining the so called *jianpu* notation used in the originals. As for the lyrics, although most of them are freely accessible on the web, due to the fact that singers may make some changes according to their needs, some problems for the recognition of related lyrics for a specific aria might rise.

To access the corpus for research purposes, we refer to the website http://compmusic.upf.edu/corpora. The corpus will eventually be also available through Dunya [9],[5] a web based browsing tool developed by the CompMusic project, which also displays content-based analyses carried out in its framework for each of the culturally specific corpora that it has gathered.

3. RESEARCH POSSIBILITIES FOR THE JINGJU MUSIC CORPUS

In this section we introduce research issues of relevance for each data type in our corpus with a special focus on the melodic analysis. We discuss the application of state of the art analytic approaches to our corpus, and propose specific future work.

3.1 Analyses of audio, lyrics and scores

According to the research objectives in the CompMusic project, in whose framework our corpus has been gathered, audio data is the main research object, supported by information from metadata, lyrics and scores. For the analysis of the musical elements described in the first section, the vocal line of the arias is the most relevant element, since it renders the core melody of the piece. Consequently, segmentation of the vocal part and extraction of its pitch are needed steps. However, the timbral and textural characteristics of jingju music pose important challenges for these tasks. The timbre of the main accompanying instrument, the jinghu, a small, two-stringed spike fiddle, is very similar to that of the voice. Besides, the typical heterophonic texture results in the simultaneous realization of different versions of the same melody. These features make the extraction of the vocal line from the accompaniment difficult. Besides, octave errors are still frequent to state of the art algorithms for predominant melody extraction, especially for role-types of the male style of singing.

If audio is the main research objet, the other types of data in our corpus offer equally interesting and challenging tasks for computational analysis. The delivery of the lyrics is the main goal of singing in jingju; therefore their analysis is essential for the understanding of the genre. Of special importance for its musical implications is the analysis of the poetic structure of the lyrics, since it determines the musical one, as well as their meaning, what would help to better define the expressive function of *shengqiang* and *banshi*. Methods from natural language processing can be applied for the identification of poetic formulae, commonly used by actors for the creation of new lyrics. As for the scores, their analysis will be beneficial for the computation of intervallic preferences, creation of cadential schemata and detection of stable pitches.

However, as stated previously, the main use of lyrics and scores according to our research purposes will be as supporting elements for audio analysis. To that aim, the main computational task is the alignment of both data types to audio. This is a challenging task, since the actors, in a tradition without the authority of a composer or playwright, have certain margins to modify lyrics and melody according to their own interpretation, as far as the main features of the aria, as sanctioned by the tradition, are maintained. In the case of lyrics, this task is even more complex due to the fact that jinju uses an art language of its own, that combines linguistic features from two dialects, the Beijing dialect and the Huguang dialect

[5] http://dunya.compmusic.upf.edu

from the South [8, 16]. This combination is far from being systematic and consistent, what in many cases poses difficulties to the prediction of the phonetic representation required for lyrics to audio alignment. The music traditions researched in the CompMusic project present similar problems for these tasks, and specific approaches have been proposed by Şentürk et al. [11] and Dzhambazov et al. [4]. We intend to benefit from these works for the development of specific methods for jingju music.

Alignment of lyrics and scores to audio will be an important step for several analytical tasks. The information from these data types combined with the audio will allow a musically informed segmentation of the recording, either in vocal or instrumental sections, or in different structural units, from the couplet, a poetic structure which is the basic unit also for the musical one, to the syllable level. The absolute pitch value of the first degree can be computed by the combined information from the score and the pitch track. Finally, an especially interesting topic is the study of how the tonal information of the syllable is expressed in the melody. Zhang et al. [17] have applied computational methods to this issue within the context of the CompMusic project.

3.2. Characterization of *shengqiang* and role-type

As stated in the introduction, the two more relevant concepts for the melodic aspect of jingju are *shengqiang* and role-type. Chen [3] has attempted a characterization of these entities by means of pitch histograms. For the classification of audio fragments as vocal and non-vocal Chen drew on machine learning, and extracted the pitch of the vocal line with the algorithm proposed by Salamon and Gómez [10]. In order to overcome some limitations of the results in this work, we have carried out an initial experiment in which we have extracted pitch tracks for a subset of 30 arias from our corpus that have been manually pre-processed. The sample contains three arias for each of the ten combinations of the two main *shengqiang* and the five main role-types. We use mp3 mono files with a sampling rate of 44,100 Hz, and have annotated them with Praat [1] to the syllable level for segmentation. Pitch tracks have been obtained with the aforementioned algorithm [10] implemented in Essentia [2], whose parameters have been manually set for each aria.

The obtained pitch tracks have been used for the computation of pitch histograms. Koduri et al. have successfully characterized Carnatic ragas by histogram peak parametrization [7]. Chen has applied this methodology for the characterization of male and female styles of singing in jingju. We have expanded the same approach to our subset of 30 arias, with the aim of characterizing the ten combinations of *shengqiang* and role-types. Our initial observations give some evidence that pitch histograms will help describe some aspects of *shengqiang* and role-types as stated in the musicological literature, such us modal center, register with respect to the first degree, range and hierarchy of scale degrees, so that differences can be established between each category. Our results also show that the approach is efficient for the characterization of different role-types for the same *shengqiang*. However, differences are not meaningful when the two *shengqiang* are compared for one single role-type. Figure 1 shows how the modal center for both *xipi* and *erhuag* in a *dan* role-type is located around the fifth and sixth degrees, register with respect to the first degree and range are practically identical, and the differences in the hierarchy of scale degrees are not relevant enough.

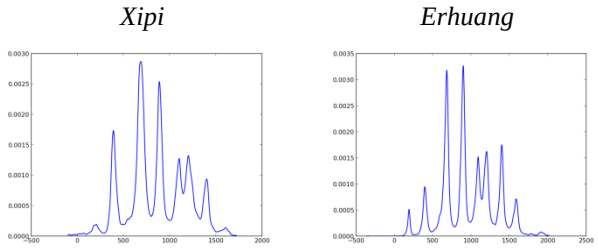

Figure 1. Pitch histograms for the *dan* role-type in the two *shengqiang*.

In our future work we propose to expand this approach by integrating the information obtained from the lyrics and the scores. In the specific case of *shengqiang*, a work of melodic similarity between arias of the *shengqiang* according to their musical structure, specially determined by the *banshi*, will shed light on the melodic identity of these entities. As for the role-type, we argue that an analysis of timbre, dynamics and articulation for each category, especially at the syllable level, will offer characterizing features that complete the information obtained from the pitch histograms.

3.3. Other research tasks

Beyond the tasks described previously, jingju music offer a wide range of research possibilities. One important aspect is the rhythmic component of the arias, mainly determined by the concept of *banshi*. An automatic identification of *banshi* and segmentation of the aria in these sections is a musically meaningful, but computational challenging task, due to the different renditions of the same *banshi* by different role-types and even different actors, as well as to the rhythmic flexibility that characterizes jingju music. The instrumental sections of the jingju arias are also an interesting research topic, especially regarding their relationship with the melody of the vocal part and how *shengqiang* and *banshi* define their features. To this task, the CDs with only accompaniment tracks will be valuable. In the framework of the CompMusic project, Srinivasamurthy et al. [13] have presented a computational model for the automatic recognition of percussion patterns in jingju. Finally, due to the importance of the acting component of this genre, and its intimate relationship with the music, jingju is a perfect case for a com-

bined research of visual and musical features, integrating computational analysis of video and audio material. Should this task be undertaken, our corpus should be expanded to include also video material.

4. SUMMARY

In this paper we have presented a corpus of jingju music, gathered with the purpose of researching its musical features from an MIR methodology. After discussing the criteria for its creation, describing its different data types and offering a general evaluation, we have suggested analytical tasks for its computational exploitation, especially focused on melodic analysis. Some state of the art approaches have been applied to a small sample of the corpus, in order to analyze their results and propose consequently further work and future tasks.

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