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Visual Analytic for Intangible Cultural Heritage in China

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Abstract
Visual analytic for intangible cultural heritage has recently developed in China. Using advanced interactive visualization tools experts can observe data distribution trends and explore the implicit relationships among data within a short time. It can enhance human cognitive and analytical abilities and improve the scientific preservation of intangible cultural heritage. To support this research topic, we have reviewed recent visualization works on intangible cultural heritage in China. We divide these works into three types: text visualization, multi-dimensional visualization, and geographical visualization. Each type is illustrated by several representative works. New development trends in this area are also discussed.

Keywords
Data Visualization, Intangible Cultural Heritage, Visual Analytics

1. Introduction

Cultural heritage is the product of human society's evolution and the work of countless human beings. It represents a precious historical legacy of material and spiritual treasures, embodying the highest levels of scientific and technological development, as well as the unique cultural connotations and spiritual values of a nation. Cultural heritage includes both tangible culture and intangible culture. Intangible cultural heritage is more vulnerable and fragile due to its non-physical nature. Moreover, it is a limited, non-renewable, and irreplaceable resource.

However, with the rapid growth of economic globalization and social modernization, intangible cultural heritage faces serious threats of being forgotten, damaged, or even disappearing [1]. Protecting and promoting intangible cultural heritage have become a pressing issue for mankind. If no action is taken, these non-renewable resources may vanish, and the intangible cultural heritage may not be properly inherited.

To address these issues, governments have proposed certain policies to preserve intangible cultural heritage within their countries. Overseas, rescue measures are primarily executed through governmental guidance, legislation, and financial support. Chinese government has launched a project to protect folk culture with supportive systems to promote the inheritance of such culture [2].

In recent years, visualization technology has been applied to investigate and protect intangible cultural heritage [3, 4]. Visualization is a technology that uses the perceptual ability of the human eye to visually represent data for better cognition. It transforms incomprehensible data into visual elements, to enhance understanding about the data. By presenting a large amount of data, visualization has a unique advantage

in communicating and disseminating of intangible cultural heritage by extracting visual elements and converting them into a visual output, so that viewers can quickly grasp important information.

For example, research on visual analytics for Peking Opera scripts has received much attention [5]. Wei et al. [6] studied Songci by analyzing the relationships of content, emotion, and meaning from the viewpoint of visual analytics. Interactive visualization has also been adopted to help scholars understand the knowledge behind intangible cultural heritage [4]. Cen et al. [7] used visualization to explore traditional Chinese medicine (TCM) and illustrated the relationship of 64 hexagrams in the Book of Changes (Yi Jing).

This work provides an overview of visual analytics for intangible cultural heritage in China and focuses on works that present Chinese intangible cultural heritage from the perspective of visualization. The article is organized as follows. First, we obtained data of intangible cultural heritage from the official websites. Second, we analyzed the collected visualized works of intangible cultural heritage in China. Based on a typical visualization pattern, these works can be categorized into three types: text visualization, multi-dimensional visualization, and geographical visualization. Finally, we discuss the potentials of the visualization of intangible cultural heritage. This study would promote the use of visual tools in analyzing and better presenting the intangible cultural heritage.

2. Data Sources

China has a rich and diverse intangible cultural heritage that reflects the country's long history and ancient culture. The cultural heritage reminds us of its significance in strengthening a local and national sense of identity and pride. Our excellent traditional culture joins all nationalities in China together. Intangible cultural heritage can be characterized based on its history, literary, artistic, and scientific values.

The State Council published five lists of national intangible cultural heritage items in 2006, 2008, 2011, 2014, and 2021 on its official website. A total of 1,557 items and 3,610 sub-items were included. The national intangible cultural heritage is composed of ten categories: folk literature, traditional music, traditional dance, traditional drama, traditional performing arts, traditional games, traditional arts, traditional skills, traditional medicine, and folk customs. Table 1 lists these categories and Fig. 1 shows their distribution.
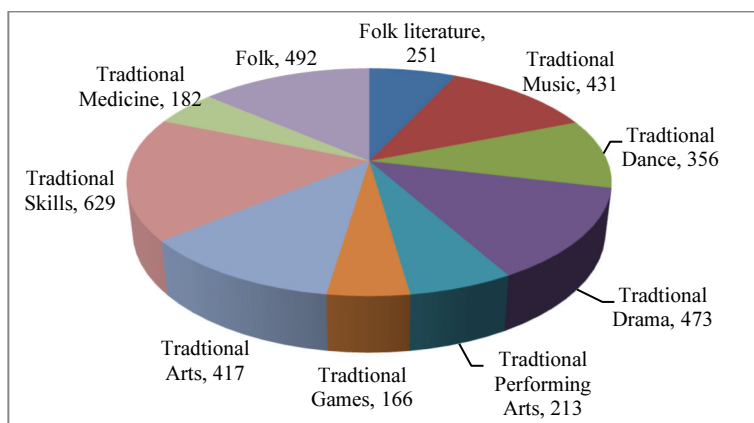
Fig. 1. Distribution of national intangible cultural heritage by category.

Table 1. Ten categories of national intangible cultural heritage

No.	Category	Total	Examples
1	Traditional folk literature	251	Gesar epic tradition (2006) Legend of Liang Zhu (2006) Legend of Dong Yong (2008)
2	Traditional music	431	Uyghur Muqam of Xinjiang (2006) Guqin and its music (2006) Morinhor of Mongolian (2006)
3	Traditional dance	356	Yangko dance (2006) Dragon dance (2006) Lion dance (2006)
4	Traditional drama	473	Kun Qu opera (2006) Yueju opera (2006) Chinese shadow puppetry (2006)
5	Traditional performing arts	213	HezhenYimakan storytelling (2006) Suzhou pingtan (2006) Northeast drum (2006)
6	Traditional games	166	Taijiquan (2006) Martial art (2006) Chinese chess (2008)
7	Traditional arts	417	Chinese paper-cut (2006) Chinese calligraphy (2008) Tibetan thang-ga (2006)
8	Traditional skills	629	Traditional Li textile techniques (2006) Traditional Jingdezhen handmade porcelain craftsmanship (2006) Lacquer techniques (2008)
9	Traditional medicine	182	Traditional Chinese medicine acupuncture (2006) Traditional Chinese medicine preparation method (2008) Traditional Chinese medicine osteopathic (2008)
10	Traditional folk	492	Mazu belief and customs (2006) Qiang New Year festival (2008) Mid-autumn festival (2006)

3. Visualization Approaches

Information Visualization is a relatively young field in computer science, but it has achieved leapfrog development in the past two decades. With the advent of big data era, visualization has become increasingly important for presenting and analyzing data. It can be applied in scientific computing, engineering design, biomedicine, cyber security, and artificial intelligence. Moreover, for social science, transportation studies, and commerce, data visualization is considered to be a fundamental skill.

Intangible cultural heritage data is often related to cultural and historical knowledge, including people, events, time, places, and activities. To comprehensively investigate visual analytics techniques for intangible cultural heritage, we collected relevant works of the past 10 years (2010–2020).

Based on typical visualization patterns, the collected works can be categorized into three types: text visualization, multi-dimensional visualization, and geographical visualization [4].
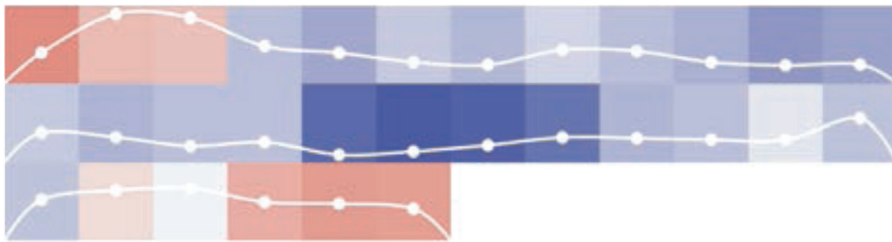
3.1 Text Visualization

Text visualization is a multidisciplinary approach that combines text mining, human-computer

interaction, with computer graphics [8]. It is the technique of using graphs, charts, or word clouds to showcase written data in a visual manner [8].

(1) Content-based text data visualization

Chen and Chen [9] proposed a system of automatic subject citation to analyze the opera King Gesar. The system covered three topics: role, region, and tribe. These topics were divided into three types: a single keyword in a single topic, multiple keywords in a single topic, and multiple keywords in multiple topics. The analysis of the King Gesar opera showed that the automatic visual indexing system could help readers locate chapters, paragraphs, and sentences in the hero Gesar domain. Peking opera is regarded as China's national opera and is the most popular and widespread opera in the country. Peking Opera script visualization system, which was developed by Hou and Zhang [5] adopted text visualization to visualize the script based on three perspectives: overview map, fingerprint map (Fig. 2), and plot maps (Fig. 3). For audiences who are unfamiliar with folk art, the system can guide them to understand the distribution of scripts under different attributes to learn about different roles and professions. The system assists Peking Opera fans to find out scripts that they are interested and explore more with better understanding.

**Fig. 2.** Peking Opera scripts fingerprint. Adapted from [5].
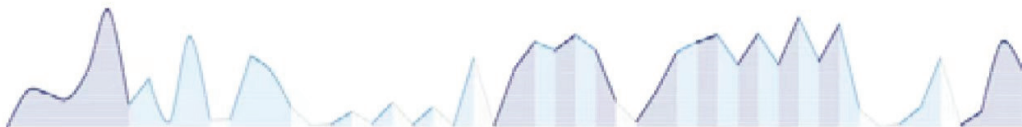
Fig. 3. Peking Opera scripts plot diagram. Adapted from [5].

(2) Time-based text visualization

Time order is a natural perspective for human to analyze collected documents. Many scholars have introduced time order into text visualization. One classic design for time-based text visualization is the changes of topics in documents over time. The topics of text flow like a river along the axis of time with the direction from the left to the right, in which different topics are represented by different color bands. Hu [10] used theme river to visualize the style changes of Songci over time. Different colors in the theme river represent different themes of Songci. Li et al. [11] designed a time diagram to reflect the evolution of Inner Mongolia's intangible cultural heritage at different stages. As can be shown in Fig. 4, the vertical axis represents the level of attention, and the horizontal axis is the approval time. The dot represents an intangible cultural heritage.

(3) Sentiment-based text visualization

Text visualization can not only analyze information based on keywords and topics but also incorporate emotions. Wei et al. [6] established a visual system for Songci text correlation and spatio-temporal analysis based on data from the Fudan Ancient Chinese Poetry database, the chronological map of Tang and Song literature, and CBDB. The system uses colors and polylines to represent sentiment and intonation, respectively. Similarly, Feng et al. [12] designed and implemented a visual system for Chinese classical poetry. To help users understand the system, the authors used a radar chart to represent the multi-dimensional attributes of poetry, such as rhythms and emotions.
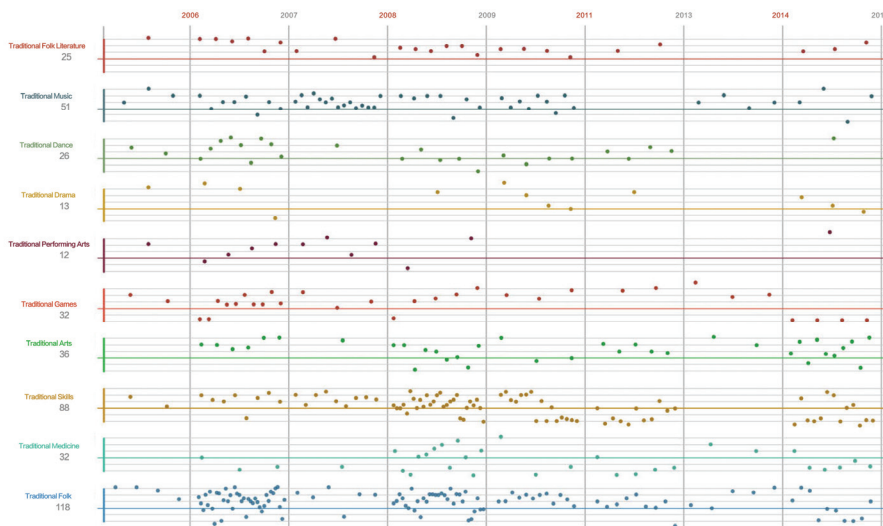
Fig. 4. Time-based visualization of intangible cultural heritage in Inner Mongolia. Adapted from [11].

3.2 Multi-dimensional Visualization

Multi-dimensional data are prevalent in intangible cultural heritage, making it challenging to understand and extract their attributes. Experts have proposed a multi-dimensional visualization approach to understand and present the dataset. This approach has achieved considerable success in analyzing intangible cultural heritage.

Using the G/S model, a comprehensive platform that manages spatial information was built to protect Qiang nationality's intangible cultural heritage. The 3D display of the platform is capable of conveying depth to the viewer so that it can efficiently share massive special information to better protect intangible cultural heritage [13]. A multi-dimensional visualization model of the intangible cultural heritage is set up based on the spatial database of the intangible cultural heritage [14]. From multi-dimensional and spatio-temporal perspective, the model studied the intangible cultural heritage and analyze its spatial evolution and spatial relationship. Taking time and batches as series, He et al. [15] revealed the development of the national intangible cultural heritage lists. The perspectives involved the type of the reviewed items, regional distribution, age, gender, and nationality of the inheritor etc. He et al. [15] used stacked bar charts, scatter plots, and statistical charts to present the cultural heritage's category and geographical distribution, the location of its productive protection bases, and inheritors' information. By studying the character, artifact, and human elements of intangible cultural heritage, Chen [16] visualized

the national intangible cultural heritage information in Jiangsu province. The visual design method makes the protection of intangible cultural heritage more effective, sustainable, and systematic.

3.3 Geographical Visualization

Geographical visualization is a technology that translates geospatial data, spatial information, and structural information into graphics to reveal the complex relationship behind the geospatial data. There are three forms of this visualization approach and they are based point, based point-line, and based area.

To explore the evolution of the style and sects of Songci on a macro level, researchers have made a map to describe poets' travel routes based on geographical data. Using geographical-based scatter plots, Li et al. [11] mapped traditional arts in Inner Mongolia (Fig. 5). The size of plots represented the degree of overlapping. Wang et al. [17] applied ArcGis tools to generate a distribution map of Hukou Qingyang Opera successors. Combining asp.net and SQL database, a visual map of Hebei region is designed to illustrate cultural resources [18]. WebGIS, which is a time and space prototype software, a system has been built to collect and store the Guqin celebrities' distribution [19]. The system showed that Guqin celebrities preferred to stay in cities that were vibrant, thriving centers of culture that offer a wealth of opportunities to engage in historical and cultural activities.
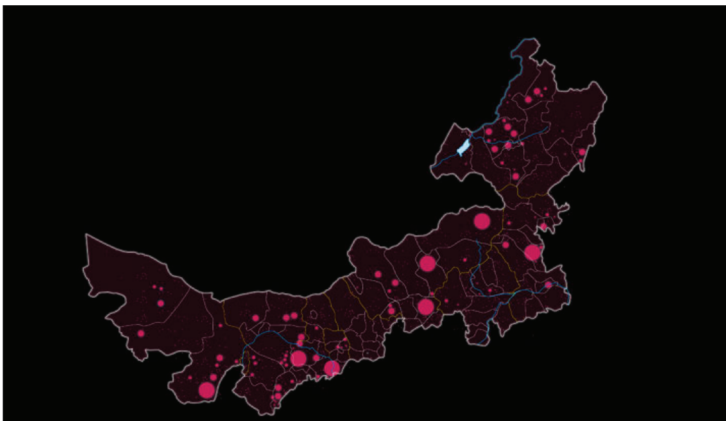
Fig. 5. Inner Mongolia intangible cultural heritage based on geographical location. Adapted from [11].

4. Discussion

Visual analytics is a promising tool in the study and protection of intangible cultural heritage in China, but there are still some limitations.

First, although visual exhibition is a powerful and promising tool to protect intangible cultural heritage, when data is missing or difficult to access, they are not always the best solution. In addition, visualization methods cannot handle tasks such as automatic classification, image recognition, or the generation of traditional cultural content. However, it can be combined with machine learning, which is a rapid-developing technique, to extract visual features. In this way, we can go beyond the manual annotation of intangible cultural heritage and this combination of techniques has greater potential in future application.

Second, visualization translates data into interactive graphs. It contains two elements, namely repre-

sentation and interaction. However, existing visualization of intangible cultural heritage in China often support exhibition and browsing but are short of interaction. Recently, interactive visualization has been one the most important focus in visualization research. The goal of interaction techniques is to improve cognitive ability of computers. As means of interaction techniques, touch screens, writing pens, virtual reality and augmented reality can be applied in the presentation of intangible cultural heritage. Through recognizing and analyzing users' actions and gestures, visualization tools can bring the audience a more immersive experience and interaction with intangible cultural heritages' multimedia materials.

Third, current works only cover visual analytics of intangible cultural heritage in China based on our collected papers. These works have provided valuable insights, nevertheless, more studies should be done to investigate its application in the same field of other parts of the world. International cooperation and national efforts should be made to study intangible cultural heritage.

5. Conclusion

This paper has investigated the application of visual analytics techniques in analyzing and presenting intangible cultural heritage in China. These analyzed works are categorized into three types: text visualization, multi-dimensional visualization, and geographical visualization. This paper has introduced some representative results based on the three types. It can be concluded that visualization is a powerful and effective tool for analyzing intangible cultural heritage and has the potential to contribute to the protection of intangible cultural heritage. However, it should be noted that visualization-based approaches are not the only solution for the digitalization of intangible cultural heritage. Other technologies, including artificial intelligence and machine learning, are also good tools in this field. We hope that this research can encourage and inspire more researchers to explore the possibilities of visual analytics of intangible cultural heritage and contribute to its development.

Acknowledgement

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