Mathematical Modelling-Based Conservation and Digital Reform of Poyang Fishing Songs

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Abstract: This study aims to apply mathematical modelling methods focusing on the fishing songs of Poyang Lake for its conservation and digital reform. Through the principles of abstraction, model building and parameter estimation of mathematical modelling, we will quantitatively analyse the efficiency of cultural heritage and the degree of influence of digital reform. Specific methods include time series analysis, data mining and optimisation models. These tools will provide theoretical support and quantify the complexity of the problem by introducing corresponding mathematical models and formulas.

Keywords: Mathematical Modelling; Poyang Fishing Song; Digital Reform; Fishing Song Conservation

1. Introduction

The fishing song of Poyang Lake represents the intangible cultural heritage of Jiangxi, which contains rich cultural and musical values. This paper focuses on how mathematical modelling methods can be used in order to study and protect this valuable cultural heritage in depth. Mathematical modelling is a powerful tool for solving practical problems, and its basic principles include problem abstraction, model building and parameter estimation. We will apply these principles to the problem of fishing songs at Poyang Lake in order to create appropriate mathematical models to quantify the efficiency of cultural heritage and the degree of impact of digital reform. Specific methods such as time series analysis, data mining and optimisation modelling will provide us with powerful tools for in-depth study of the connotations and historical evolution of this intangible cultural heritage.

2. The Basic Connotation and Contemporary Development of Poyang Fishing Songs

2.1 History and Cultural Connotation of Poyang Fishing Songs

Since ancient times, the land of Gan Poyang has been a famous land of fish and rice. Li Tiaozhi's "Notes on South Vietnam" said, "The Yue people are good at singing, and they sing whenever there is an auspicious occasion". "The granary is rich in manners, the clothes and food are sufficient, and one knows honour and disgrace" (from "The Records of the Grand Historian - Guan Yan Liezhuan") life is colourful and full of the culture of country customs and rituals. In the change of history, Poyang Lake area has witnessed economic and cultural prosperity. At the end of Ming and the beginning of Qing Dynasty, many kinds of traditional music emerged, among which Poyang fishing song is the representative. According to the legend, in the Daoguang period of Qing Dynasty, Hubei artist Shuai Dehua introduced the art of fishing song into Poyang Lake area, and the oral and mental teaching of the artistes over the generations has made it a local traditional music form with great characteristics of Poyang Lake. Poyang Fishing Song carries the characteristics of labour and unique repertoire, ethnic singing, accompaniment and dance, recording the progress and development of regional traditional art civilization. It is a part of the cultural wealth of Jiangxi Province and an "artistic treasure" of Poyang Lake area.

2.2 Artistic Characteristics and Contemporary Development of Poyang Fishing Songs

2.2.1 Artistic Characteristics of Poyang Fishing Songs

Poyang Fishing songs are generally in seven-character stanzas, two-stanza or four-stanza style, with the two-stanza style consisting of two stanzas above and below, with the main focus on succession, while the four-stanza style embodies the principle of "beginning, end, and end". In terms of tuning, the most common mode is the levistic mode, followed by the angular mode. The melodic composition is mostly motivated by a major second + minor third triad, and in the smooth progression, big jumps are inserted upwards, such as pure fifths and minor sixths, reflecting the sense of openness and expansiveness.

The melody has more decorative notes, such as leaning and sliding. In terms of rhythm, the syncopated rhythm is the most typical, showing the dynamics of rippling water. For example, in "Four Seasons Fishing Song" ("Good Scenery on Poyang Lake") of Poyang Fishing Song, its typical features such as melodic "freedom", five and six degree jumps, syncopated rhythms and so on, are reflected in most of this folk song. The lyrics include folklore, civil affairs, lyrics and scenery, etc., which are more colloquial, with "ai, ah, na, yo" like other fishing songs (see music example 1), with the musical style brought by the local language of Poyang Lake Basin.

Score 1: The Four Seasons' Fishing Song, bars 1-8

2.2.2 Cultural Value of Poyang Fishing Songs

The theory of value transmission emphasises that culture is an important way of value transmission, and music transmits social values and moral norms through lyrics and melody, which helps to shape the values of individuals. Poyang fishing songs carry the historical stories and cultural memories of the Poyang Lake area and record the social, cultural and spiritual outlook of the area in the past, and it has unique artistic expressions and aesthetic concepts. Experimental studies by social psychologist Muzafer Sherif have shown that shared experience and cooperation can promote group cohesion and willingness to cooperate, and that music, as a kind of shared experience, has the potential to promote social cohesion. Intangible cultural exchanges are often an important part of community and collective activities, and they can facilitate communication and interaction between people. By enjoying and participating in compilations and performances together, people increase opportunities for mutual understanding and friendship, while at the same time strengthening community cohesion and identity.

In conclusion, intangible cultural heritage such as Poyang Fishing Song has rich cultural value, which is not only the music treasury of an ethnic group or region, but also an important link between the past and the present, and between different cultures.

3. Mathematical modelling and analysis

3.1 Mathematical modelling approach

(1) Problem abstraction: Mathematical modelling requires the abstraction of real-life problems. This principle emphasises the importance of translating problems into mathematical form, and problem abstraction is the key to successful mathematical modelling (Bäck, 1997). Therefore, we need to properly abstract the problem of conservation and digital reform of fishing songs in Poyang Lake in order to apply mathematical modelling methods.

(2) Model building: creating a mathematical model is the core of mathematical modelling(Georgi N,2016). Mathematical modelling of the fishing song problem at Poyang Lake requires the creation of a mathematical model that reflects the nature of the

problem.

(3) Parameter estimation: Parameter estimation is a key step in mathematical modelling. It involves determining the parameters in a mathematical model so that the model can better fit realistic data. The principles of parameter estimation are supported by a wide range of theories, including the principles of parameter estimation in statistics (Hoang, 2022).

3.2 Overview of specific methodologies

(1) Time series analysis: time series analysis is a method commonly used to deal with time series data. It includes trend analysis, cyclical analysis and seasonal analysis of data (Almut E. D, 2017). For the data of fishing songs in Poyang Lake, time series analysis will help to understand its historical evolution and future trends.

(2) Data mining: data mining is a method of extracting useful information from large-scale data. It can be used to analyse the cultural connotation, characteristics and influencing factors of fishing songs (Khanbabaei,2018). Through data mining, we can gain an in-depth understanding of the cultural value and inheritance process of fishing songs in Poyang Lake.

(3) Optimisation model: Optimisation model is a method used to solve complex problems. It can be used to optimise resource allocation, decision making and other problems (Yuhan Hu, 2023). In the conservation and digital reform of the fishing song of Poyang Lake, the optimisation model can be used to optimise the allocation of resources in order to achieve the best conservation and inheritance effect.

These basic principles and specific methods of mathematical modelling will provide strong tools and theoretical support for our research on the conservation and digital reform of the fishing songs of Poyang Lake.

3.3 Specific Methods of Mathematical Modelling of Poyang Fishing Songs

(1) Data collection and organisation: sources of data include historical recordings, audio files, performance data, etc (Luenberger, 2008). Data collation needs to refer to the methodology of Introduction to Data Mining (Tan, Steinbach, & Kumar, 2006) to ensure the quality and usability of the data.

(2) Data pre-processing: the data pre-processing stage will apply the methods in Data Analysis and Data Mining (Berry & Linoff, 2004), including data cleansing, missing value processing and outlier detection. These steps help to ensure data quality and prepare for subsequent analyses.

(3) Time series analysis: the basic principles of time series analysis methods include lag correlation, smoothness test and seasonal decomposition. These principles are described in detail in Time Series Analysis (Wei, 2006). Depending on the characteristics of the time series, we will apply appropriate models such as ARIMA (Autoregressive Sliding Average Model with Differences) (Box, Jenkins, & Reinsel, 1994).

(4) Data Mining: In order to reveal the key themes and cultural elements in the fishing songs, text mining methods from Data Mining: Concepts and Techniques (Han, Kamber, & Pei, 2011) will be used. The book describes the process of text mining, including word segmentation, topic modelling and sentiment analysis.

(5) Optimisation models: the theoretical foundations of mathematical optimisation models are detailed in Linear Programming and Network Flow Problems (Bazaraa, Sherali, & Shetty, 2013). We will develop corresponding optimisation models for optimal resource allocation and decision making.

Finally, we will provide specific data analysis results and model application cases based on the above analysis steps in order to demonstrate the practical application of mathematical modelling methods in the conservation and digital reform of fishing songs in Poyang Lake.

4. Conclusion

Through the mathematical modelling approach of this study, we researched and designed a mathematical model of the fishing song of Poyang. We used tools such as time series analysis, data mining and optimisation models to quantify the efficiency of cultural inheritance and the degree of influence of digital reform, providing theoretical support for the protection and digital reform of fishing songs. This study provides a powerful method and direction for better protection and inheritance of the fishing song culture in Poyang Lake, which helps to protect and inherit this important intangible cultural heritage.

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