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Analysis of Structured Data Processing and Aesthetic Experience in Classical Dance Theatre Works

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ABSTRACT

Dance drama is a comprehensive art with dramatic conflicts and plots based on the use of dance's own language system, which plays an important role in cultural dissemination and aesthetic experience. The article designs a resource library of classic dance drama works in the way of WEB site, establishes a data dynamic distribution strategy to deal with structured data, and combines the consistent hash algorithm to optimize the load balancing of structured data in the resource library. Then, a graph convolutional neural network model and a sample-weighted aesthetic classification model are combined to establish an aesthetic assessment model for images of classical dance drama works, and a regularized matching module is designed. For the application effectiveness of the structured data processing strategy, the structured data processing of the classic dance and drama works resource library is verified, and the hyperparameters of the model, evaluation results and ablation experiments are also analyzed. Combined with the data in the resource library of classic dance drama works, the aesthetic experience of the audience was analyzed using a questionnaire. After using the dynamic distribution strategy to process the structured data, its write and query times were shortened by 40.05% and 17.89% compared to before use, and the response time under different index query load balance degrees did not exceed 55ms.The accuracy of the aesthetic assessment model for classical dance and drama works was 48.85%, and the accuracy improvement of the G-AANet model compared to BoTNet ranged from 0.93% ~ between 6.12%. The resource base of classical dance drama works established through structured data processing helps to enhance the audience's aesthetic experience of dance drama works and helps them to appreciate the spiritual connotation of dance drama works.

Keywords: structured data; dynamic distribution strategy; consistent hashing; graph convolutional network; G-AANet model; classical dance drama works

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1. Introduction

All along, the excellent traditional culture of the Chinese nation has been committed to the pursuit of the beauty of "imagery", which is also the aesthetic purpose of the traditional Chinese dance drama art. In the traditional Chinese art genre of dance drama, the implicit and timeless imagery expresses the excellent traditional culture of the Chinese nation, carries forward the excellent aesthetic spirit of the Chinese nation and the output of excellent culture [1-2].

Dance drama is a dramatic art presented on the stage, which is attributed to stage drama and takes body language as the main form of expression [3]. Dance drama consists of a variety of elements and is a comprehensive stage art, the most important of which are character, plot, stage, and conflict [4-5]. In the past ten years, Chinese dance drama, as a performance form integrating dance performance, dramatic conflict and music, has begun to step into the stage of large-scale development in artistic creation and market operation, showing strong creative vitality and dynamism [6-8]. How to make dance theater for the enjoyment of the public, so that the spirit of art is rooted in the general public, so that artistic creation, artistic research and artistic education work is facing a huge challenge to carry out smoothly. In the context of this digital era, the digital choreographic analysis of dance drama works can be realized by combining digital technology with traditional dance drama performance through computer backstage operation [9-12]. Through detailed investigation, collection and sorting of artistic resources of dance drama, the data resources formed in the process of digitization are systematically collected, preserved and applied to realize the construction of digital resource library of dance drama [13-16]. The use of cutting-edge technology empowers cultural and artistic resources, improves the utilization efficiency and sharing degree of artistic resources, and further promotes the long-term development of dance drama culture and spirit [17-18].

In the context of the new era, classical dance drama works begin to pursue the aesthetic value of the classics through continuous innovation of aesthetic freshness and character originality, and then release a deeper and richer expression of the main idea. In this paper, on the basis of analyzing the necessity of digital innovation of classic dance drama works, a resource base of classic dance drama works is constructed based on WEB site. When structured data processing is carried out in the resource library, multi-dimensional data mapping is used to calculate the most suitable cluster access point to build a dynamic distribution strategy for classical dance and drama works, and then load Gini coefficient combined with consistent hash algorithm to balance the server load, so as to enhance the utilization of structured data in the resource library of classical dance and drama works. In order to realize the aesthetic evaluation of classic dance and drama works, this paper introduces sample-weighted aesthetic classification and constructs an image aesthetic evaluation model by combining the GCN model. The effectiveness of the structured data processing strategy is verified based on the classic dance and drama works resource library, the results of the aesthetic assessment of the classic dance and drama works are analyzed, and the role of the classic dance and drama works resource library on the performance of the aesthetic experience is explored with the questionnaire.

2. Classic Dance Theater Works Resource Library and Structured Data Processing

Dance drama is regarded as a jewel in the crown of art, which absorbs the essence of various artistic disciplines such as literature, drama, music, fine arts, architecture, dance, etc. It is the drama of music and the music of drama. In the face of the ever-flowing river of classic dance theater art, it is the responsibility of the contemporary people to press the shutter and solidify the information to provide an immediate reference for future research. In this way, we record a classic dance drama from different dimensions, such as film, sound and image, by means of "on-site, on-presence and online", to explore the humanistic sentiment and aesthetic value behind the classic dance drama works, and to pass on the practical significance and cultural value carried behind the classic dance drama. The use of digital means to realize the creative transformation and innovative development of the new and precious resources of classic dance drama works, and to promote the new classic dance drama works to "live" up, pass on, and go farther.

2.1. Construction of Resource Library of Classical Dance Theater Works

2.1.1. Digitization of Classic Dance Theatre Works. The resources of classic dance and drama works are rich in content, and we can start from the following aspects when organizing the resources and carrying out the construction of the resource library as well as its application:

1) Collecting and organizing the resources of classic dance and drama works. In this part, we need to carry out in-depth research and investigation on the history, types, movements and dance music of classic dance and drama works, and collect various books, documents, video materials and oral information.

2) Apply digital technology to process the resources of classic dance and drama works, so that these resources have the characteristics of digitization, in order to facilitate the subsequent research and inheritance.

3) Conduct training for classic dance and drama works so that they have the power to be passed on. In this regard, the old generation of classic dance theater artists will be invited to participate in the oral transmission to ensure the continuation of the pure tradition of classic dance theater.

4) We can carry out innovations around classic dance dramas and perform and promote them on the basis of innovations. Classic dance dramas can be fused with modern dance and stage art to create more contemporary and ornamental works, thus attracting the attention and participation of more young people.

5) Rooting in the grassroots, displaying cultural charms, and helping the construction and application of resources for classical dance and drama works. Practitioners of classical dance and drama can cooperate with local communities and cultural organizations to jointly carry out projects for the construction of resources for classical dance and drama works, so as to ensure the participation and contribution of many parties, thereby promoting exchanges and understanding between different cultures and enriching cultural diversity.

2.1.2. Resource Library of Classic Dance Theater Works. Based on the construction idea of digitization of classical dance and drama works, in order to further expand the dissemination range of classical dance and drama works and innovation inheritance well, and also to provide a resource display and sharing platform for classical dance and drama learners, enthusiasts and researchers, the resource library of classical dance and drama works needs to be designed and realized in the form of a WEB site [19].

In essence, the classic dance and drama works resource library designed in this paper is a distributed application program based on B/S structure, and its three-tier architecture is shown in Figure 1. According to the preliminary demand analysis, the system functional structure of this classic dance drama works resource library is designed here, which contains four sub-systems, namely, basic information management, classic dance drama clips management, feature classification query and system configuration. In terms of implementation, the backend database adopts Microsoft SQL Server database, and ASP.NET tools are used to complete the front-end implementation of the classic dance drama works resource library. Relying on the network crawler technology to obtain many types of classic dance drama works from the Internet, the data of classic dance drama works are stored in the resource library through pre-processing, which lays the foundation for the digitization of classic dance drama works.

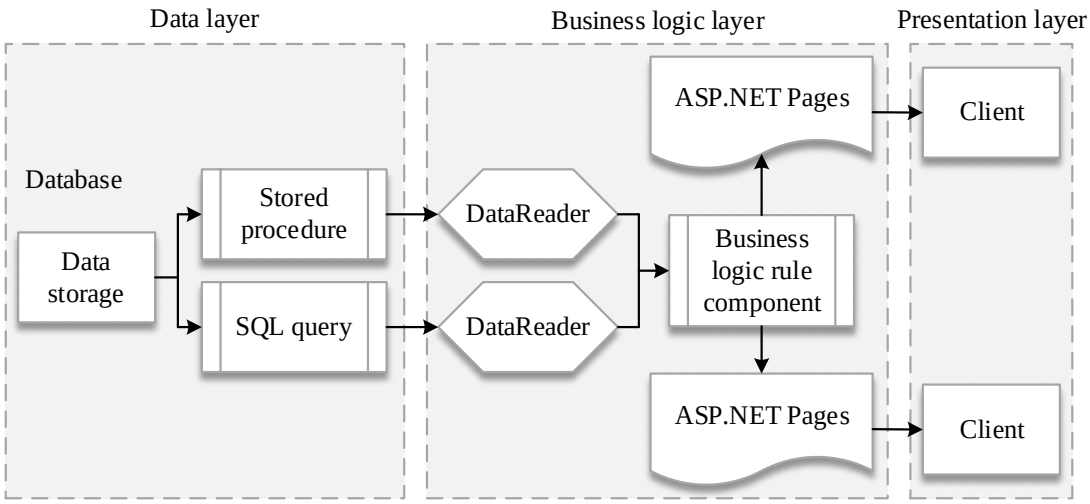


Fig. 1. The framework of the library of classical dance drama

Resource base of classic dance and drama works is an effective means of protecting and inheriting classic dance and drama works with the resources of classic dance and drama works as the content and database technology as the support. After collecting all-round information about the original classic dance and drama works, this paper has sorted out the information from many angles and systematically constructed the resource database of classic dance and drama works on this basis. This is not only of great significance for the informatization of classic dance drama works and the sharing of resources of excellent classic dance drama works, but also provides a reference for the construction of digital resource libraries of other types of classic art.

2.2. Design of structured data processing strategy

2.2.1. Strategy for dynamic distribution of work data. The data that exists in the classic dance theater works resource library is structured data, the so-called structured data that is the database, generally refers to the data that can be expressed and stored using relational databases, realized with two-dimensional logical expressions. The unit of behavior, one line of data represents an entity information, and each line of data has the same attributes, stored in the database. In addition, structured data can be represented in data or uniform structures, such as numbers, symbols, etc. Therefore, structured data are stored and arranged with regularity, which helps to realize operations such as query and modification.

In this regard, in order to further realize the effective selection of structured data in the classical dance and drama works repository, this paper relies on the multidimensional data mapping to calculate the most suitable cluster access point, and then constructs the dynamic selection strategy (NSS) to realize the dynamic distribution of classical dance and drama works data. Its specific contents are as follows:

1) Initialization phase. The initialization phase, in which the data of a classical dance theater production undergoes its first transmission, is a static selection process, so a two-tier ring polling mechanism of object sets (OSs) and cluster nodes (DSs) is used for direct selection. The total number of nodes owned by the cluster is denoted as Sum_{DS}. There are several OSs on the i nd DS, and the total number of OSs on the corresponding nodes is denoted as $SunD(i),OS$. The total number of OSs owned by the cluster is $\mathrm{Sum}_{OS} = \sum_{i=1}^{Sum_{DS}} Sum_{D(i),OS}$. A two-layer torus of DSs and OSs is established for the data distribution.

In the case of large files, the number of small files (denoted as Sum_{split}) that are sliced up also affects the specific data distribution differently. If $Sum_{split} > Sum_{OS}$, according to equation (1), the OS ring rotates X times and the DS ring rotates Y frames to complete the data distribution. If $Sum_{OS} > Sum_{split} > Sum_{DS}$, according to equation (2), the OS ring will not move, and the DS ring will move M turns and then turn N frames. If $Sum_{OS} < Sum_{DS}$, the DS ring will move Sum_{split} frames. That is:

$$Sum_{split} / Sum_{os} = X.....Y \tag{1}$$

$$Sum_{split} / Sum_{DS} = M.....N \tag{2}$$

2) Dynamic adjustment phase. The uniform distribution of the object collection has been ensured as much as possible by the initialized dual-round query strategy, but the performance of the DS changes drastically as the amount of data changes drastically with the increase of user operations. If a node requests a large amount of data due to another service or a node suddenly drops out of line resulting in a load imbalance, and the Classic Dance Theatre Works repository continues to transmit the data with the dual polling strategy, it will result in a chaotic distribution of cluster data. To address this problem, the selection of injection nodes and classical dance and theater works repositories needs to be dynamically adjusted. After the initialization of the cluster is completed, the dynamic monitoring and adjustment phase (CMS) is carried out.

CMS collects the load of each node of the cluster at regular intervals and calculates the weight $DS_{i,weight}$ of each node of the cluster according to equation (3) and calculates the weight DS_{weight} of the cluster as a whole according to equation (4), and selects the point with the smallest weight as the primary access point of the NSS selects the node with the smallest weight excluding the primary access point as the backup access point. Namely:

$$DS_{i,weight} = DS^{*}_{i,status} DS_{i,used} / (DS^{*}_{i,capaciy} H)^{*} Sum_{OS} \tag{3}$$

$$DS_{weight} = DS_{TotaiUsed} / DS_{TotalCapacity} \tag{4}$$

Where, $DS_{i,weight}$ denotes the weight value of the ind node, and the weight value, indicates that the higher the load on it, the smaller the available resources. $DS_{i,status}$ denotes the working status of the ith node, $DS_{i,status}$ is 0 when the node is disabled, and $DS_{i,status}$ is 1 when the node is working normally. $DS_{i,wsd}$ denotes the load value of the ith DS, $DS_{i,capacity}$ denotes the total available resources of the ith node, H is the node heterogeneity value, which can be manually configured, and SumOS denotes the number of OSes distributed on the current node, to avoid the distribution of a large collection of objects to the same node, and the system avoids selecting the disabled or unavailable nodes. The system will avoid selecting failed or unavailable nodes. After selecting a suitable node, according to the object collection ring pointer on the node, jump one frame to complete the NSS selection. After completing the NSS selection, according to the order of OS records on the corresponding node, select them in turn, and finally complete the data injection.

Through the two phases of initialization and dynamic adjustment, on the one hand, it solves the operational obstacles caused by the large amount of injected data from fixed single nodes, and on the other hand, the dynamic adjustment of the injected nodes ensures the smooth operation of the overall cluster, and realizes the multi-dimensional mapping between the data collection of classical dance theater works and the storage nodes. After completing the selection of injection nodes, a node round-robin is constructed, and the data blocks are distributed in the cluster with a polling strategy.

2.2.2. Load Balancing with Consistent Hashing. In the structured data processing of classical dance and drama works resource pools, due to the different capacity of resource pools for data processing requests, different requests have different demands on resources, CPU-intensive tasks have a higher CPU utilization rate, and IO-intensive tasks have a higher RAM utilization rate.

The data transfer of classical dance and drama works may cause differences in load between resource libraries, resulting in the resources of classical dance and drama works not being fully utilized. In this paper, we propose the BDF algorithm, which constructs the load Gini coefficient combined with the consistent hash algorithm to balance the server load, as a way to improve the utilization of structured data in the classical dance and drama works repository, and to avoid the load imbalance caused by the overuse of a single resource [20].

In this paper, we mainly collect the CPU and RAM utilization, denoted as $L(\text{CPU})$ and $L(RAM)$, respectively, and the corresponding thresholds are denoted as $T(CPU)$ and $T(RAM)$, respectively. The real-time load factor of the server numbered i is denoted as:

$$R(S_i) = W_1^* L(CPU_i) + W_2^* L(RAM_i) \tag{5}$$

Where W_1 and W_2 denote the weight share of CPU and RAM, respectively, $W_1 + W_2 = 1$. In the same way, the real-time average load factor of the server cluster is calculated $R(avg)$, which represents the theoretical optimal load factor of each server in the server cluster, setting the balancing parameter α. When $R(S_i) - R(avg) > \alpha$, the server is considered to be overloaded. After collecting the CPU and RAM utilization of each server in each cycle, the calculation is performed for $T(CPU)$ and $T(RAM)$, i.e:

$$T(CPU) = \frac{\sum_{i=1}^{n} L(CPU_i)}{n} \tag{6}$$

$$T(RAM) = \frac{\sum_{i=1}^{n} L(RAM_i)}{n} \tag{7}$$

Set up two collections of servers, denoted $S(CPU)$ and $S(RAM)$. Add servers with $L(CPU)$ less than $T(CPU)$ to $S(CPU)$ and remove servers with $L(CPU)$ greater than $T(CPU)$ from $S(CPU)$. The responsible load equalizer will prioritize the selection of servers from the $S(CPU)$ collection for CPU-intensive tasks, and treat $S(RAM)$ in the same way.

The consistent hash algorithm induces virtual nodes and cuts the hash ring into n equal parts equally, with more virtual nodes corresponding to the greater load capacity of the servers.

In the algorithm proposed in this paper, the load balancer first collects the performance parameters of each server, using $P(CPU)$ and $P(RAM)$ to indicate the performance of the server's CPU and RAM that can be used, respectively, and calculates the maximum load capacity of the server $P(S_i)$, i.e., the maximum load capacity of the i th server, according to the weighting formula in Eq. (5). Then:

$$P(S_i) = W_1 * P(CPU_i) + W_2 * P(RAM_i) \tag{8}$$

Based on the result calculated in equation (8), the initial number of virtual nodes for each server is calculated as:

$$VN_i = \frac{P(S_i)}{\text{gcd}} \cdot n \tag{9}$$

where gcd denotes the greatest common divisor of $P(S_i)$, n is a positive integer, and VN_i denotes the initial number of virtual nodes of the i th server. With CVN_i denotes the current number of virtual nodes of the i th server, if load balancing is required, the current number of virtual nodes of the server with higher load ratio is scaled down to reduce the probability of that server to be selected in the next cycle.

In this paper, by using the concept of Gini coefficient and combining it with virtual nodes, we propose to use load Gini coefficient to measure whether the load is balanced or not in the whole server cluster. The load capacity of the server is quantified, i.e., it is reflected by the number of virtual nodes.

Assuming that the load ratio of the i th server is $R(S_i)$, it can be assumed that there are VN_i virtual nodes whose load ratio are all $R(S_i)$, and the load Gini coefficient is calculated [21]. The Gini coefficient is calculated as:

$$G = \frac{1}{2n^2 u} \sum_{j=1}^{n} \sum_{i=1}^{n} \left| Y_j - Y_i \right| \tag{10}$$

The overall load of the server cluster is measured by the load Gini coefficient, which can more intuitively reflect whether there are large load differences between servers. Based on the load Gini coefficient of each

cycle, it determines whether the server cluster needs load balancing, and when load balancing is needed, the number of virtual nodes is adjusted in a gradient style according to the size of the load rate.

3. GCN-based aesthetic assessment of classic dance drama images

With the concept of creative transformation and innovative development, it is required to make efforts to realize the development of traditional culture, so that classic dance and drama works can be effectively inherited. In order to further promote the prosperity and development of classic dance drama works, it is necessary to carry out reforms in many aspects, with the digitalization of the classic dance drama works of the "two creations", and do a good job of inheritance and promotion. Thus, combined with digital means to further enhance cultural self-awareness and cultural self-confidence, to normalize and standardize the classic dance drama works to bring sustainable development.

3.1. Graph Convolutional Neural Networks and Aesthetic Classification

3.1.1. Graph Convolutional Neural Network Models. Graph Convolutional Neural Network (GCN) is designed as a method to extract feature information from graph structures and is used for node classification, graph classification, edge prediction, and embedded representation of graphs with structures such as convolutional layers, pooling layers, and so on [22]. It includes the index I of the graph and the feature vector V of the Laplace matrix L of the graph. Specifically, the graph convolutional network is iteratively trained up to the k th layer, the input of the layer is signal x_k and the output of the layer is signal x_{k+1}, the former has $|I|\times f_{k-1}$ elements and the latter has $|I|\times f_k$ elements, the specific training process is as follows:

$$x_{k+1,j}=h(V\sum_{i=1}^{f_{k-1}}F_{k,j,j}V^{T}x_{kj})(j=1,\cdots,f_k) \tag{11}$$

where $h(\cdot)$ is the nonlinear activation function and $F_{k,t,j}$ is the weight parameter of layer k in the iterative training of the model in the form of a diagonal matrix. In each training, matrix multiplication operations need to be performed on V and $F_{k,j}$ as well as V^{τ}, resulting in a computational complexity of $O(n^3)$. When the input graph structure is more complex, the computational overhead of the model will rise sharply.

Based on the nature of Chebyshev polynomials, the learning of weight parameters is converted into the learning of filters instead of eigenvalue diagonal matrices, which are computationally expensive. The input signal of a graph convolution network is specifically localized as $x\in\mathbb{R}^N$, which consists of the eigenvectors of each node in the graph data structure. The graph convolution is defined as the convolution of the input signal with a filter of parameter $\theta\in\mathbb{R}^N$ by Fourier transform, i.e:

$$g_\theta * x = Ug_\theta U^{T}x \tag{12}$$

where U is the matrix consisting of the eigenvectors of the Laplacian matrix L of the graph data structure, and the Laplacian matrix L is computed as:

$$\begin{aligned}L&=D^{\frac{1}{2}}(D-A)D^{\frac{1}{2}}\\&=D^{\frac{1}{2}}DD^{\frac{1}{2}}-D^{\frac{1}{2}}AD^{\frac{1}{2}}\\&=I_N-D^{\frac{1}{2}}AD^{\frac{1}{2}}\\&=U\Lambda U^{T}\end{aligned} \tag{13}$$

where D is the degree matrix of the nodes in the graph data structure, A is the adjacency matrix of the nodes in the graph data structure $I_N=UU^{T}$, and Λ is the diagonal matrix formed by the eigenvalues of

L. From Eq. (13), the computation of the filter g_θ in Eq. (12) is related to the eigenvalues of L. Therefore, let the filter parameter g. Be evaluated as a function of Λ, i.e.:

$$g_\theta = g_\theta(\Lambda) \tag{14}$$

The solution of the filter function for Eq. (14) is fitted using the truncated expansion of the Chebyshev polynomial $T_k(x)$ in the k nd order and normalized to Λ, i.e:

$$g_\theta(\Lambda) \approx \sum_{k=0}^{K} \theta_k T_k(\tilde{\Lambda}) \tag{15}$$

$$\tilde{\Lambda} = 2\Lambda / \lambda_{\max} - I_N \tag{16}$$

where θ_h is the coefficient vector of the Chebyshev expansion, Λ needs to be normalized as in Eq. (16) in order to satisfy the unfolding condition of the Chebyshev polynomials, and $\lambda_{\max}$ is the largest eigenvalue of L. Therefore, based on the above derivation, the graph convolution operation of Eq. (12) is specifically defined, i.e.,:

$$g_\theta * x = \sum_{k=0}^{K} \theta_k T_k(\tilde{L}) x \tag{17}$$

$$\tilde{L} = 2L / \lambda_{\max} - I_N = U \tilde{\Lambda} U^T \tag{18}$$

Compared to previous graph convolutional operations methods, Eq. (17) is locally connected, its operation depends on the range of k st order neighboring nodes of the central node, and the operation complexity of $T_k(\tilde{L})x$ in Eq. (17) is $O(K|E|)$, which is linearly related to the number of edges. Therefore, the operation speedup is more pronounced when the graph data structure is a sparse graph.

3.1.2. Aesthetic classification based on sample weighting. In order to better carry out aesthetic assessment for classical dance theater works, this paper proposes a sample-weighted aesthetic classification method as a way to solve the problem of uneven distribution in the dataset of classical dance theater works. Given a relevant image of a classic dance theater work, a high weight is assigned when the aesthetic score is in a certain interval, and samples other than that are assigned lower weights. In aesthetic categorization, the boundary samples are due to label ambiguity (the labels of the samples themselves are less certain), so their weights should be cut down. Ultimately, the SoftMax loss function based on binary weighting can be expressed as:

$$\mathrm{L}_{whl} = -\frac{1}{N}\sum_{i=1}^{N}\sum_{c=1}^{C} w_i 1(y_{hl}^{ic}=1)\log p(\hat{y}_{hl}^{ic}=1|X_i), w_i = \begin{cases} a, & 4 < A_{score}^{i} < 6 \\ b, & others \end{cases} \tag{19}$$

where w_i is the weight of the i nd image and A_{score}^{i} represents the aesthetic score of the i th image. In fact, we do not care about the specific values of a and b, but only consider their ratio b/a. This ratio controls the binary weight assignment. In the training phase, the total loss function L for both branches can be expressed as:

$$\mathrm{L} = \mathrm{L}_{whl} + \mathrm{L}_{att} \tag{20}$$

where the sample-weighted loss function based on the uniform parameter Θ to find the gradient can be expressed as:

$$\frac{\mathrm{L}_{whl}}{\partial\Theta} = -\frac{1}{N}\sum_{i=1}^{N}\sum_{c=1}^{C} w_i 1(y_{hl}^{ic}=1)\frac{\partial \log p(\hat{y}_{hl}^{ic}=1|X_i)}{\partial\Theta} \tag{21}$$

where w_i is involved in the operation outside the gradient.

3.2. *Aesthetic assessment models and regularized matching*

3.2.1. Modeling framework for aesthetic assessment. Under the idea of graph convolutional neural network and sample weighting-based aesthetic classification, this paper considers that the aesthetic assessment of classical dance drama works is a process of extracting information about visual and aesthetic features of the works, constructing correlations of image regions, and outputting a distribution of aesthetic quality scores. As a result, this paper proposes a GCN-based aesthetic assessment framework for classical dance theater works, G-AANet shown in Figure 2. The framework mainly contains three parts, i.e., deep convolutional neural network, GCN, and regularized matching module.

Firstly, the original classical dance theater work image information is input to the deep convolutional feature extraction network to extract the global and local visual information of the image to get the visual and aesthetic features. Secondly, the convolutional feature segmentation group is organized into a feature graph structure, where the features of each region are connected to each other and input into a graph convolutional neural network, which performs convolution operation on the feature graph and outputs the distribution of preaesthetic quality scores of this image from a certain node. Finally, the regularized matching module contains a pre-determined distribution table of aesthetic quality scores, the distribution table contains a plurality of different distributions of aesthetic quality scores, and the pre-distribution of aesthetic quality scores in the distribution table is used to calculate the BTCY distance value for each distribution in turn.The BTCY distance is a way to calculate the similarity of the two discrete histograms, and also reacts to the disparity between the two scores distributions, and ultimately obtains the aesthetic quality scores that have the smallest BTCY distance with the pre-distributed scores in the distribution table. The aesthetic quality score distribution with the smallest BTCY distance in the distribution table is obtained as the final output.

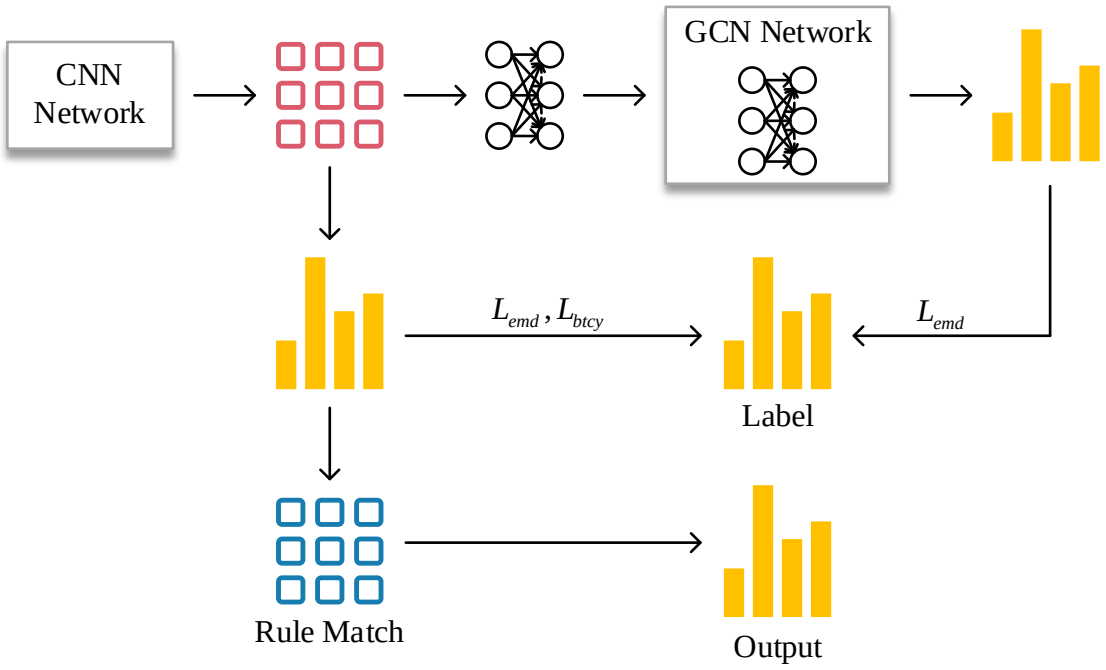


Fig. 2. The image of the G-AANet aesthetic evaluation model

3.2.2. Regularized Matching Module. The regularized matching module is a matching table containing a plurality of predefined distributions of image aesthetic quality scores, and before outputting the final result, a BTCY distance difference calculation is performed to select the one that has the smallest difference between the individual distributions in the matching table and the pre-score distribution as the final result. The discrete likelihood distribution BTCY distance is defined as:

$$D_{(p,q)} = -\ln \sum_{i=0}^{k} \sqrt{p_i q_i} \tag{22}$$

Where k equals to 10 represents that the distribution of image aesthetic quality scores contains 10 score dimensions from 1 to 10, p_i represents the score in dimension i of the predicted score, and q_i represents the score in dimension i of the target score.

First, assume that the distribution of image aesthetic quality scores output from the graph convolutional neural network is $\bar{Y}$, and the set of aesthetic quality score distributions in the matching table is $\tilde{Y} = [\tilde{y}_1, ..., \tilde{y}_i]$. Then, multiple distributions in $\bar{Y}$ and $\tilde{Y}$ are sequentially subjected to the BTCY distance operation, which is computed in the following equation:

$$\arg\min(\tilde{y})_{p_i \sim \nabla, q_i \sim \tilde{y}_i} = -\ln \sum_{i=0}^{9} \sqrt{p_i q_i} \tag{23}$$

Finally, the matching score distribution with the smallest distance is taken as the final image aesthetic quality score distribution.

4. Structured Data Processing and Aesthetic Evaluation of Dance Theater Works

Nowadays, the classic works of art are interpreted in a new way by dance drama, which not only requires the works themselves to be classic enough, but also requires a large number of excellent dance drama works to fill the market as the performance market of dance drama expands year by year and the appreciation level of the audience improves continuously. Relying on modern technology to realize the digital innovation of classic dance drama works, and giving classic dance drama works more diversified communication methods can provide new ways for the inheritance and development of classic dance drama works, and also provide a convenient way to enhance the aesthetic experience of the audience.

4.1. Processing Validation of the Dance Theater Works Repository

4.1.1. Experiments on dynamic distribution of data. In this paper, two experiments are designed and implemented, relying on data from a repository of classic dance theater works. Experiment A is designed to establish a baseline performance by utilizing the U-ID field in the dataset to implement data partitioning, but the specific hardware configuration of the cluster (including CPU capacity, memory size and disk space) is not taken into account in the process, and data writing and querying operations are performed directly. Experiment B is built on the basis of Experiment A, also using the U-ID field as the basis for partitioning, with the significant difference of incorporating the dynamic data distribution strategy proposed in this paper. In order to enhance the stability and reliability of the experimental results, each group of experiments is run independently ten times and the average time consumption of the corresponding operations is calculated, and the results of the two groups of experiments are shown in Figure 3.

The average execution time of data writing and querying in Experiment A is 735.53s and 291.12s respectively, and the average execution time of data writing and querying is shortened to 440.94s and 239.05s in Experiment B after the application of the data dynamic partitioning strategy proposed in this paper.Comparing the average results of the two groups of experiments, it can be clearly observed that the adoption of this paper's data dynamic partitioning strategy in the classic Dance Theater Works Resource Suffering to carry out structured data processing efficiency presents a significant improvement. The average time of data writing operation is reduced by about 40.05%, while the average time of data querying is also shrunk by about 17.89%. This series of quantitative data strongly proves that the dynamic data partitioning strategy can effectively optimize the resource allocation and accelerate the writing and retrieval process of structured data when facing the actual structured data processing tasks, which in turn improves the overall efficiency of structured data processing. The algorithm implements a more refined data allocation strategy based on the node's CPU idle rate, memory utilization rate and disk idle rate.

Through this mechanism, Experiment B achieves dynamic adaptation and efficient utilization of cluster resources while performing data writing and querying operations. The dynamic data partitioning strategy combined with the cluster hardware condition is of great value in improving the efficiency of structured data processing, and it is feasible to apply it to the structured data processing of the classic dance drama works resource library.

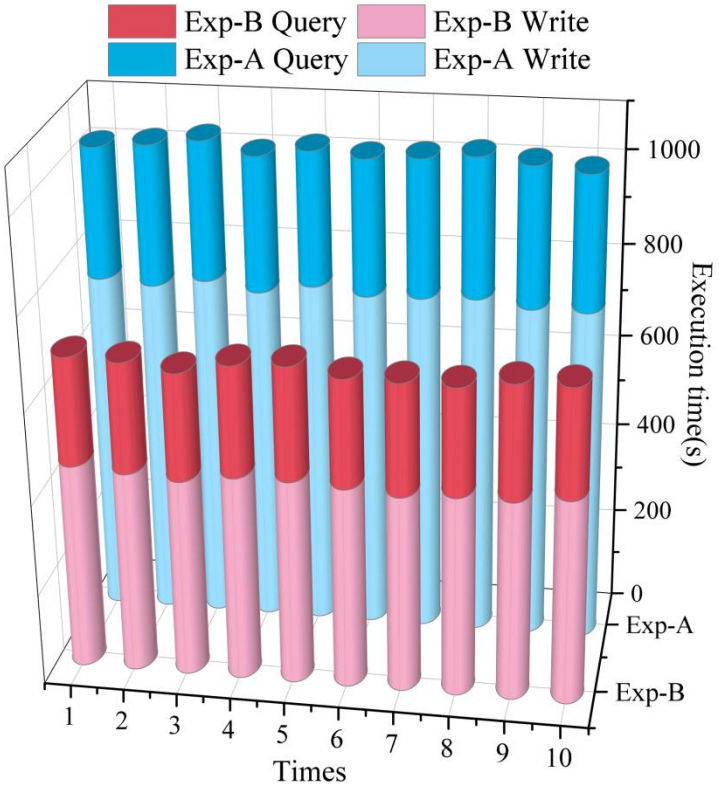
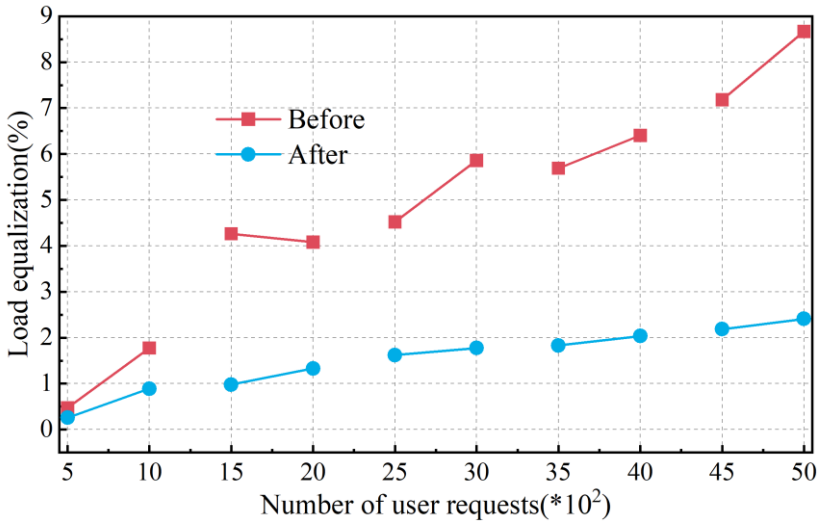


Fig. 3. The time-consuming results of the two experiments

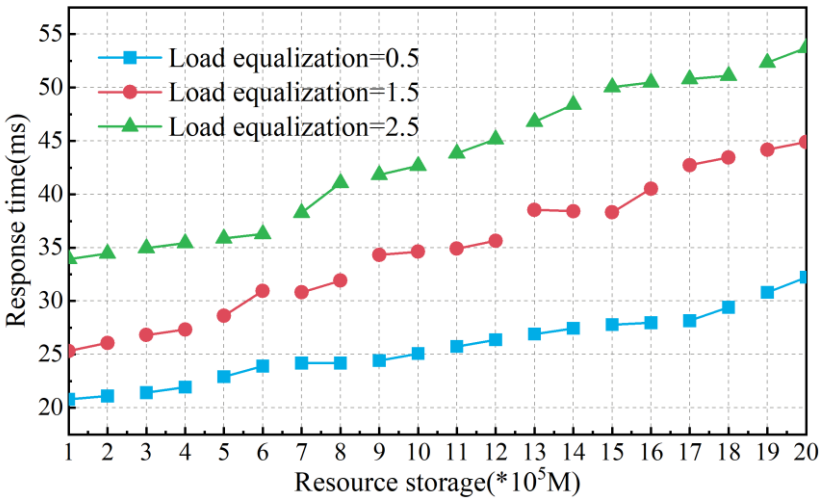
4.1.2. Structured data load balancing. In order to verify the index query load balancing ability of the optimization method based on the consistent hash algorithm in the classic dance and drama works repository, the experiment creates 10 groups of different sizes of user index query service requests, and at the same time issues index query requests to the classic dance and drama works repository. The index query load balance degree is used as the evaluation index, the smaller the load balance degree is, the stronger the load balance ability is. Response time refers to the time that the server reacts to the application issued by the user, which is an important index to measure the performance of the resource library, and can also reflect the size of the operation cost from the side. Based on the consistent hash algorithm proposed in this paper to index query operations on the classic dance and drama works resource library under different data to analyze the index query performance of the method under different index query balance through the response time index. Fig. 4 shows the load balancing changes of the classic dance and drama works repository, where Fig. 4(a)~(b) shows the load balancing degree and index query response time, respectively.

Before the load balancing operation on the classic dance and drama works resource library, the index query load distribution of the resource library is very unbalanced, and the maximum load balancing degree reaches 8.67% and fluctuates greatly. Through the optimization method based on the consistent hash algorithm to adjust the index query load of the classic dance and drama works repository, the load balance degree has decreased significantly, the maximum load balance degree of 2.41%, and the overall curve trend is smoother. This indicates that the optimization method based on the consistent hash algorithm achieves the index query load balance of the classic dance and drama works resource library, and can better handle the structured data in the classic dance and drama works resource library. When the optimization method

based on the consistent hash algorithm processes a large amount of structured data under different index query load balancing degrees, the index query response time of the classic dance and drama works repository has a better performance. When the data volume in the classic dance and drama works repository is within 10*105M, the response time of the three index query load balancing degree is not more than 45ms, and when the data volume in the classic dance and drama works repository reaches 20*105M, the response time of the three index query load balancing degree is not more than 55ms, especially when the load balancing degree is 0.5%, the response time of the whole process is less than 32ms. 32ms or less. This indicates that the optimization method based on the consistent hash algorithm efficiently completes the index query of the classic dance drama works repository with different data volumes, and provides a more ideal processing method for efficiently processing structured data in the repository.



(a) Load balancing of the repository



(b) Index query response time of the repository

Fig. 4. The load balancing of the classic dance drama repository

4.2. Analysis of Aesthetic Assessment of Classic Dance Theater Works

4.2.1. Hyperparametric experiments on the model. The aesthetic assessment model of classical dance and drama works designed in this paper is constructed on the basis of the GCN model, and the data in the resource library of classical dance and drama works are inputted into the network in the form of images, while the number of domain samples K input into the network determines the size of the sampling graph of each center point. The larger the sampling graph is, the wider the initial sensory field of the node is, and

the richer the geometric and topological information that can be expressed. However, it may also introduce unimportant redundant information, and at the same time lead to the problem of high computational cost in the training process of the model. Therefore, this experiment samples different values of the number of neighborhood samples and tests the related accuracy experiments on the image dataset of classic dance theater works. The correlation between the accuracy and the number of neighborhood samples is obtained by choosing the edge crossing, edge length, stress, neighbor angle, node overlap and neighborhood similarity index as dependent variables, denoted by I1~I6, as shown in Fig. 5. Where the x-axis is the number of neighborhood samples, the y-axis is the value of the coefficient of determination, and each fold line represents the trend of a certain aesthetic index.

It can be seen that with the increase of the number of neighborhood samples K, the trend of each aesthetic index is slightly different, in which the edge length, stress and neighborhood similarity show a trend of increasing and then decreasing, and the other indexes are maintained in a stable range. Overall, the maximum gain is obtained when the number of neighborhood samples is 30 to 35. In view of the fact that the complexity of the model increases linearly accordingly to the increase in the number of samples, this paper sets the number of model neighborhood samples to 32 as the number of samples for the input network, aiming to improve the accuracy of the aesthetic evaluation of the images of classic dance theater works.

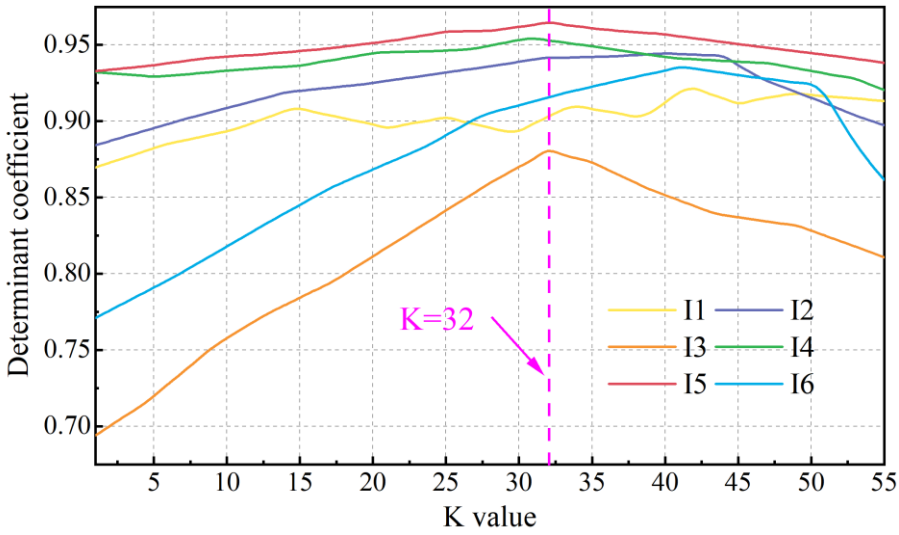


Fig. 5. The trend of accuracy changes under different K values

4.2.2. Comparative results of aesthetic assessment. In this paper, we take the image profiles in the resource library of classic dance theater works as the data source and make it into a dataset, which contains not only aesthetic scores in classic dance theater works, but also a variety of different categories of dance theater labels, which specifically include animals, architecture, portraits, landscapes, night scenes, plants, and still lifes, and so on. The experiment takes the accuracy rate as the comparison index, and selects Alexnet, Resnet and BoTNet trained by other CNNs in this paper as the comparison models, and obtains the comparison results of the aesthetic assessment of classical dance theater works by different models as shown in Table 1.

As can be seen from the table, G-AANet has a great improvement over Alexnet in the seven categories of the classical dance drama works dataset, compared to which it achieves a performance improvement of 1.59% to 18.14% on all types. Compared with Resnet, the G-AANet model shows different degrees of improvement in most attribute scores, with a minimum improvement of 1.24% and a maximum improvement of 8.68%. The introduction of aesthetic classification structure based on sample weighting gives us an insight into the aesthetic classification of the image structure of classical dance theater works. Compared with BoTNet, the G-AANet model in this paper has different degrees of improvement in each type, and its improvement ranges from 0.93% to 6.12%. Because the graph convolutional neural network module and regularized matching module are added, the G-AANet model can assign different weights to

different types of image information of classical dance and drama works, learn the corresponding image features with different attributes in the dataset, and realize the aesthetic classification and evaluation of images of classical dance and drama works.

Table 1. Aesthetic assessment comparison results (%)

Data Type	Alexnet	Resnet	BoTNet	G-AANet
Animals	45.78	48.51	48.82	49.75
Buildings	63.26	63.44	66.73	68.52
People	51.27	62.39	63.29	69.41
Landscapes	49.51	51.48	52.14	53.69
Night scenes	48.72	48.92	50.65	52.03
Plants	51.48	53.64	53.93	59.78
Still things	58.65	51.56	58.79	60.24
Total	42.39	43.07	45.64	48.85

4.2.3. Model ablation comparison experiments. In order to verify the importance of the sample-weighting-based aesthetic classification module as well as the regularized matching module for the aesthetic assessment of images of classical dance drama works, a single aesthetic classification model (Model A) and a regularized matching model (Model B) are trained separately to obtain the classification results. After that, the two are combined to form the aesthetic assessment model for images of classical dance and theater works proposed in this paper, and the classification results are obtained after training. The classification results of the three models are compared. The experimental results on the dataset produced in this paper are shown in Table 2.

As can be seen from the table, the classification accuracy using the G-AANet model is 48.85% on the image dataset of classic dance theater works. Using the proposed image aesthetics assessment model for classical dance drama works in this paper, it performs well in all subcategories of the dataset, especially in the three subcategories of animals, plants, and still life, and improves the accuracy of image aesthetics biclassification by 4.73%, 12.99%, and 6.71% than that of using a single image aesthetics biclassification based on regularized matching, respectively. In the remaining four subcategories, the classification effect is lower than that of the single sample-weighted aesthetic binary classification accuracy, with the improvement ranging from 0.5% to 2.0%. It is fully illustrated that the introduction of sample-weighted aesthetic categorization information and regularized matching module is needed to effectively ensure the accuracy of aesthetic assessment of classical dance drama works and provide assistance to enhance the aesthetic experience of audiences on classical dance drama works.

Table 2. Results of ablation experiments (%)

Data Type	Model A	Model B	G-AANet
Animals	44.18	45.02	49.75
Buildings	67.06	60.13	68.52
People	68.24	62.65	69.41
Landscapes	51.72	47.51	53.69
Night scenes	51.51	41.28	52.03
Plants	42.64	46.79	59.78
Still things	51.72	53.53	60.24
Total	40.19	42.37	48.85

4.3. Analysis of the Aesthetic Experience of Classic Dance Theater Works

The highest principle of the ancients was meaning, and the highest achievement of successful artistic treatment is beauty. Thus, "beauty" is not only the concentrated manifestation of the artistic characteristics and achievements of a work of art, but also a key part of analyzing artistic production. In this section, we choose "The White Haired Girl" in the resource library of classic dance drama works as the object of analysis, and study the aesthetic experience of this dance drama work on the audience. Based on the evaluation results of the image aesthetics assessment model of classic dance drama works, the questionnaire star platform was used to design a questionnaire on the aesthetic experience of the classic dance drama work "The White Haired Girl". After the questionnaire was collected, entry statistics were carried out to obtain the results of the audience's aesthetic experience of the classic dance drama work "The White Haired Girl".

4.3.1. Poetic Language and Romanticism. As a concentrated expression of aesthetic thought and culture in the revolutionary historical period, the ballet "The White Haired Girl", through the design of the plot content, characterization, music melody and dance movement arrangement in the production process, reveals different aesthetic connotations, and brings the audience a unique aesthetic experience as well as a profound impact of thought. The dance drama "The White Haired Girl" tells the local story of China with the help of western ballet art, and uses the poetic language of revolutionary romanticism to narrate and convey the feelings, and then integrates the strong emotional expression into the artistic performance of the dance drama. It not only makes the whole dance drama full of rich romanticism poetry, with the lyrical effect of passionate outburst, but also makes the whole dance drama show full of revolutionary enthusiasm, and then condenses the aesthetic style of revolutionary romanticism.

The ballet "White-haired Girl" uses the poetic language of romanticism to combine the "reality" of real life with the "emptiness" of yearning life, and combines the "reality" of the characters' emotion with the "emptiness" of the dance expression. It combines the "reality" of real life with the "emptiness" of yearning for life by using the poetic language of romanticism, and combines the "reality" of characters' emotion with the "emptiness" of dance gestures' expression to realize the unity of the revolutionary reality and the revolutionary ideal, which makes the dance drama have the artistic style of revolutionary romanticism on the whole.

4.3.2. Tragic Narrative and Heroism. Tragedy is a tragic conflict between the inevitable demands of history and the practical impossibility of realizing those demands, a social conflict. Among them, "the inevitable demands of history" refers to the side of the righteous, showing the spirit of resistance and struggle, while the realization of justice is not smooth, need to experience conflict, defeat, sacrifice and destruction, so this process constitutes a tragedy. Embodied in the work of art, the value of tragedy is specifically manifested through the performance of the subject-object conflict, the struggle of the arduous process, so that the main body of the tragedy to show their own strength of confidence and certainty, so as to abstractly show the ideal prospect. The ballet "The White Haired Girl" carries this strong tragic color.

Although the tragic narrative of the ballet "The White Haired Girl" is always permeated with a profound sense of fate, it never shrinks and is disillusioned. It praises hard work and heroic resistance, and celebrates the greatness and nobility of human beings. Even though it is colored with pessimism and melancholy, it inspires us with profound truth, magnificent poetry and heroic style. Therefore, this narrative technique not only makes the ballet contain the aesthetic meaning of tragedy, but also makes the ballet further complete the shaping of great characters and the expression of heroic spirit. The heroic spirit of yearning for light, pursuing justice and struggling tenaciously conveyed in the ballet "The White Haired Girl" also gives the audience a unique spiritual tremor and impact, which is inspiring and gives people strength.

5. Conclusion

The article establishes a resource library of classical dance and drama works based on WEB, constructs an image aesthetics assessment model of classical dance and drama works by combining graph convolutional neural network, and carries out a validation analysis based on the data in the resource library. The average execution time of data writing and querying is reduced to 440.94s and 239.05s compared with that before the strategy is used, and the response time under different index query load balances does not exceed 55ms when the data volume of classical dance and drama works reaches 20*105M. When the neighborhood sampling K of the model is 32, the response time of G-AANet is less than 55ms. 32, the accuracy of the G-AANet model for the aesthetic assessment of images of classical dance drama works is relatively high and the generalization ability is stronger. When the G-AANet model is used for the aesthetic evaluation of images of classical dance and drama works, its accuracy can reach up to 69.41%, which improves the performance by 18.14% compared with the Alexnet model. Relying on the data of the classic dance drama works resource library, the aesthetic experience for the audience can clarify the spiritual connotation of the works and help the audience feel the aesthetic value of the classic dance drama works.

References

[1] Zhang, Y. , & Tiwari, R. S. . (2022). The construction of video resource sharing platform for drama and film and television majors. Springer, Cham.

[2] Gallist, N. , Lattner, M. , Lankes, M. , & Jürgen Hagler. (2022). Build your world - meaningful choices in a hybrid stage play. Springer, Cham.

[3] Ajidahun, C. O. (2017). Dramatic literature, digitisation and cultural mediatisation: a postmodernist perspective. OGIRISI: A New Journal of African Studies, 13, 187-199.

[4] Petri, I., & Julien, F. (2017). Digitising the Performing Arts. Assessment Report.

[5] Sugita, I. W., Pastika, I., & Puasa, I. (2023). Development of a drama gong performance model: an effort to preserve the traditional Balinese drama in the digital era. International Journal of Visual & Performing Arts, 5(1).

[6] Suandi, I. N., Bandem, I. M., Mudana, I. W., Partami, N. L., & Aryanto, K. Y. E. (2020). Delivering Balinese dance to the digital era: multimedia-enriched dictionary. Preservation, Digital Technology & Culture, 49(2), 59-65.

[7] Sugita, I. W., Setini, M., & Anshori, Y. (2021). Counter hegemony of cultural art innovation against art in digital media. Journal of Open Innovation: Technology, Market, and Complexity, 7(2), 147.

[8] Liu, S. (2023). Creative Innovation Research on the Ethnic Song and Dance Drama. Art and Performance Letters, 4(12), 50-53.

[9] Chen, S. (2023). A Probe into the Form of Dance Performance in Drama Performance. Highlights in Art and Design, 4(1), 97-99.

[10] Iaţeşen, M. C. (2024). SCENOGRAPHIC IDEA AND CONCEPT IN CONTEMPORARY THEATER OF ANIMATION, FROM TRADITION TO ARTISTIC EXPERIMENT. Review of Artistic Education, (27), 162-175.

[11] Zakopoulos, V., Makri, A., Ntanos, S., & Tampakis, S. (2023). Drama/theatre performance in education through the use of digital technologies for enhancing students' sustainability awareness: A literature review. Sustainability, 15(18), 13387.

[12] Bannikova, K., Fryz, P., Voronova, N., Bondarenko, A., & Bilozub, L. (2023). Digital transformations in culture and art: new opportunities and challenges. Amazonia Investiga, 12(61), 348-358.

[13] Chen, L. (2021, October). Development and application of computer three-dimensional auxiliary system in dance creation. In Proceedings of the 2021 5th International Conference on Electronic Information Technology and Computer Engineering (pp. 1416-1419).

[14] Demian, N. (2022). Reframing of contemporary dance. Învăţământ, Cercetare, Creaţie, 8(1), 65-70.

[15] Li, N. (2022). Multimedia Drama Imaging Technology Based on Big Data Information System. Mobile Information Systems, 2022(1), 4765619.

[16] Sovhyra, T., Ivashchenko, I., Strelchuk, V., Pyvovarova, K., & Tykhomyrov, A. (2023). The Problem of Introduction of Digital Technologies in the Performing Arts. ACM Journal on Computing and Cultural Heritage, 16(1), 1-8.

[17] Odefunso, A. E., Bravo, E. G., & Chen, Y. V. (2022). Traditional African dances preservation using deep learning techniques. Proceedings of the ACM on Computer Graphics and Interactive Techniques, 5(4), 1-11.

[18] Tonkoshkura, O. (2022). Theatre in the Age of Digital Technologies. Artistic Culture. Topical Issues, 18(2).

[19] Temi Ami Williams,Christina Georgia Serghides & Andreas Aristidou. (2024). Digitizing traditional dances under extreme clothing: The case study of Eyo. Journal of Cultural Heritage145-157.

[20] Jiang Xiaoming,Yang Huamin,Yang Ya,Chen Zhanfang & Zhou Shengzong. (2021). Cluster load balancing algorithm based on dynamic consistent hash. Journal of Intelligent & Fuzzy Systems(3),4461-4468.

[21] Jin Guo & Shengbing Zhang. (2020). Research on equilibrium scheduling of airborne network resource based on load Gini coefficient. International Journal of Information and Communication Technology(2).

[22] Chen Wang,Kaizhong Zuo,Shaokun Zhang,Chunyang Liu,Hao Peng,Wenjie Li... & Biao Jie. (2024). TADGCN: A Time-Aware Dynamic Graph Convolution Network for long-term traffic flow prediction. Expert Systems With Applications125134-125134.