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Research Article

Aesthetic Value Evaluation for Digital Cultural and Creative Products with Artificial Intelligence

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The domestic cultural and creative industry has abundant resource advantages and broad development space. The design for cultural and creative products has evolved rapidly with the objective to improve its quality. The cultural and creative industries have seen rapid growth in the recent years wherein digital technologies have been incorporated with the traditional methodologies. The digital cultural and creative aspect acts are extremely important in the dissemination of traditional culture on the network platform. This is also supported by the state vigorously to implement innovative industrial policies. However, the adoption of digital technology in the cultural and creative industry is a novel approach. But there exists lack of understanding in terms of its nature and development protocols. It is thus necessary to study relevant theories to guide the development of digital cultural and creative industry. The increasingly prosperous aesthetic culture, especially development for cultural and creative industries, has comprehensively improved aesthetic value of the cultural and creative products. Therefore, the methods to evaluate and realize the aesthetic value of digital, cultural, and creative products are extremely important and relevant in the present day and age. In this study, neural network is used to design an improved back propagation (BP) network in order to evaluate the aesthetic value of digital cultural and creative products. At the outset, the basic idea, structural characteristics, the learning algorithm, and its flow of functioning in the BP network are analyzed. Then, an aesthetic value evaluation model of digital cultural and creative products with BP network is developed. Next, considering the shortcomings of BP network, a segmentation adaptive strategy is used to improve the view field and step size for artificial fish swarm algorithm (AFSA). Finally, the improvised algorithm is verified wherein the simulation results reveal improvement in algorithm convergence speed as well as improvement in optimal solution accuracy as part of the adaptive improvement approach.

1. Introduction

Digital cultural creation is the process of transforming and recreating cultural content by means of digital media technology and finally forming a virtual cultural work. At the same time, it relies on the dissemination, interaction, and feedback of the Internet platform. In the entire production and service process of digital cultural and creative products, everything is realized under new technical means, so it can also be called new cultural and creative. Compared with physical cultural and creative products, digital products have no real form and physical appearance. However, in terms of creation and design, it often overlaps with other professional fields, such as media, computer, animation games, film and television director, and music art. Compared with other practical and functional digital products, it also bears the responsibility of inheriting culture, which is a concentrated expression of culture and technology [1–5].

Different from the physicality of traditional and digital cultural and creative products, focus on multidimensional new media audio-visual, and participate in more interactivity, participation, entertainment, and sharing. At the same time, the use of short videos, animations, applications, online games, social media, and other Internet means to transform and carry cultural content. Digital cultural and creative products have extensive network media, and the cultural and creative content produced by designers can be transmitted directly to users' terminals through the network to achieve point-to-point direct transmission. The interpretation data at the audience level can also be easily fed back to the producer through the network to realize information exchange. At the same time, users can also use their own media platforms to carry out secondary dissemination of cultural content, forming an exponential dissemination effect. This rich communication mode forms massive and objective big data information, which constantly promotes the rapid upgrading of digital products. This kind of influence and speed is unmatched by traditional industries that rely solely on sales statistics [6–10].

Technology, science, and society have made digital cultural and creative products more and more prevalent throughout time. Designing and manufacturing products has undergone a paradigm shift. Instead of emphasizing functionality, consumers now value aesthetic attributes like design and the whole user experience. Most consumers evaluate and select most commodities from an aesthetic point of view, and consumers' aesthetic taste and judgment ability have been doubled. In this context, the combination of design innovation and aesthetic economy is becoming the most important productive force for social development.

The aesthetic value for digital cultural and creative products, as third value in addition to the use value and exchange value of commodities, plays an active and important role in the composition of the product value itself, as well as in the extension of product brand culture and corporate economic benefits. It has positive theoretical and social significance to evaluate the aesthetic value for digital cultural and creative products. It can promote interdisciplinary innovation for related disciplines. In today's society, the development of the global market, information technology, and the democratization of art bring new challenges to aesthetics. There is a semiaesthetic zone between aesthetics and art and life practice. Under the guidance of innovation-related theories, digital cultural and creative product design innovation is making great contributions to academic and industrial development. Design innovation covers a wide range. In the context of aesthetic economy, whether it is microproduct innovation or macroindustry development, more detailed and in-depth research and innovation are required. For the design innovation of the aesthetic value of digital cultural and creative products, the existing research is generally limited to the field of art disciplines and designers, and the systematic and dynamic research on product aesthetic value is insufficient. Aesthetic value evaluation of digital cultural and creative products can also promote more companies to pay attention to improving aesthetic value for products. It will provide more references for enterprise product innovation design and give play to advantages of design innovation to promote national innovation and development [11–15].

The unique contribution of the paper includes development of an improved back propagation (BP) network to evaluate the aesthetic value of design culture and creative products. The structural characteristics, the learning algorithm, and its flow of functioning in the BP network are analyzed. An aesthetic value evaluation model of digital cultural and creative products with BP network is developed. A segmentation adaptive strategy is used to improve the view field and step size for artificial fish swarm algorithm (AFSA). The improvised algorithm is verified wherein the simulation results reveal improvement in algorithm convergence speed as well as improvement in optimal solution accuracy. The organization of the paper is as follows: Section 2 provides an exhaustive of the recent studies conducted. Section 3 presents the methodology followed by Section 4 which explains the results and its inferences. The conclusion is presented as Section 5.

2. Related Work

Literature [16] proposed to follow the concept of harmonious symbiosis and establish a harmonious and symbiotic relationship among tourism cultural and creative products, consumers, tourist destinations, and the natural environment and put forward ideas and suggestions to strengthen green ecological design. Literature [17] explores the sustainable development path for tourism cultural and creative product from the aspects of form design, color elements, and selection of materials. Reference [18] discusses the basic connotation, key issues, and implementation approaches related to ecological health and designs and develops the practice of cultural and creative products. Literature [19] analyzed the natural view, cultural view, and aesthetic view in the traditional creation thought and applied it to the design of products such as cultural and expo modeling, ethnic patterns, and regional materials. Literature [20] proposes to excavate traditional bamboo culture through natural and bionic design methods in traditional culture. Literature [20] believes that plant dyeing is in line with the characteristics of modern people's pursuit of health, greenness, nature, simplicity, and humanity. Combined with the characteristics of traditional hand-made design and hand-made design elements, literature [21] discusses the design methods and creative paths of related products in combination with market demand of public health care. Literature [22] proposes that traditional materials should maintain their natural form and, at the same time, be equipped with modern processing to achieve the inheritance of shape and meaning. Literature [23] puts forward the concept of cultural and creative industry. With promotion and support for national policies, the industry has developed rapidly; museum cultural and creative design become benchmark. Literature [24] pays attention to the combination of regional characteristics, national characteristics, and trend culture, forming a unique cultural and creative design culture. The distinctive feature for product design is that it promotes the parallel development of traditional and modern dual-track development from the system and, at the same time, develops modern cultural and creative; it completely maintains and inherits traditional national design.

Reference [25] argues that product appearance plays a limited but very critical role in a product. Product aesthetics have a positive and important impact on product value; it can enhance product competitiveness and sales performance, and good design can improve product use efficiency. Literature [26] argues that product styling or design contributes to product success in many ways. For example, it is easier to attract consumers, and it is easier to form logo information of enterprises and products to promote consumer identification and improve the quality of life, because using beautiful products makes people feel happier and last longer. Reference [27] tasks product design inherently includes aesthetics, and aesthetics is the underlying driver of consumer pleasure.

Aesthetics is increasingly important in new product development, market strategy, product quality, product differentiation, and competitive advantage. Literature [28] believes that product appearance and aesthetic factors are more and more important, and aesthetic factors should be integrated into the whole process of product design as an important factor. Reference [29] argues that all high-tech products, regardless of technology, require a surface full of emotions and symbolic meanings. Literature [30] believes that aesthetic design is very important to the success of enterprises through the investigation of hundreds of new enterprises based on technological innovation. It can help enterprises to break the existing market pattern with new products and reflect product differentiation. Literature [31] believes that the aesthetic economy provides consumers with in-depth experience and high-quality aesthetics for the purpose of making consumers happy. Literature [32] believes that the essence of experience economy is to produce a good feeling. The characteristics of consumption are experience, emotion, personalization, leisure, and beautification. Literature [33] believes that people consume, not only buy things, but also hope to get an emotional experience, the experience of beauty, that is, aesthetics as the object of consumption. Reference [33–35] believes that products with technical aesthetics not only give people a sense of beauty in appearance but also make people more comfortable to use. Literature [36] proposed from the macro perspective of society that establishing a scientific design concept, establishing an identification system, and establishing a modern design talent training system are three ways to enhance the aesthetic value of the overall product in society. Literature [37] believes that the beauty of products is reflected in three levels: formal beauty, technical function beauty, and social beauty. The first layer is a pleasant experience brought about by the reasonable and beautiful exterior shape, color coordination, and friendly material texture. The second layer is the rational design for the interactive interface, including high recognition, low misjudgment, ergonomic ease of operation, maintenance, and high reliability.

3. Method

This work uses IAFSA to optimize BP network and proposes IAFSA-BP network for evaluating the aesthetic value of digital cultural and creative products.

3.1. Basic BP Network. BP network is a typical information network. When given an input signal, the information is passed forward to the hidden layer. After being processed by the excitation function, the information is transmitted from hidden layer to output layer and finally converted into an output signal. In addition to the general feedforward mode, the BP network has its special features. Its algorithm process includes two parts: forward propagation and back propagation.

Forward propagation is the method by which a signal is sent from the input layer to the output layer via a hidden layer. As soon as the network output error surpasses a predetermined threshold, a back propagation link will be activated. Error will be reversely distributed to the system, and the system will also correct the weights and thresholds of neurons in each layer accordingly. This allows each layer to have more appropriate connection weights and thresholds, improving the performance of the system. Although the BP network adopts the bidirectional propagation of information in the training algorithm, its structure is still a one-way feedforward layered network. The BP network is illustrated in Figure 1.

In the layered neural network, the training method generally adopts the teacher-style learning method, and BP network is also one of them. It is a learning rule developed on the basis of the delta algorithm.

Firstly, network is initialized, and structure of BP network is determined according to the number of inputs and outputs of the actual problem. And assign random values to initial weights as well as thresholds. Output and error are then calculated as follows:

$$y = f(x), \tag{1}$$

$$E = 0.5\sum\left(y - y'\right)^2. \tag{2}$$

If the number of network iterations meets the requirements or the error accuracy is less than the set value, then the simulation effect of the network is relatively good, and the training ends. Otherwise, enter the back propagation link. According to the network error, the parameters of the network are updated.

$$w_{\text{new}} = w - \Delta w, \tag{3}$$

$$b_{\text{new}} = b - \Delta b. \tag{4}$$

This cycle is repeated until the conditions for the network to stop training are met. The pipeline of BP is illustrated in Figure 2.

3.2. Improved Artificial Fish Swarm Algorithm. AFSA is an optimization method that mimics the social behavior of schools of fish in order to achieve swarm intelligence. One of its key advantages is that it does not require any knowledge of the specifics of the problem it is trying to solve; instead, it compares the advantages and disadvantages of the situation. However, as the algorithm progresses, its convergence speed slows, resulting in a less accurate optimal solution.

Fish do not possess the advanced wisdom of fuzzy cognition and comprehensive information processing that humans have. Their purpose is achieved or emergent through the simple behavior of an individual or group, and here, four basic behaviors are defined for artificial fish.

Foraging is an instinctive activity inherent in all animals. For the foraging behavior of fish, it is generally believed that the location of the food in the water is perceived by sight or taste, and then, it chooses to swim to the location with the most food. Therefore, the foraging behavior for fish is described by the concept of fish vision.

The current state is X_a, and the new state X_b is selected. The status is represented as follows:

$$X_b = X_a + v * \text{Rand}(). \tag{5}$$

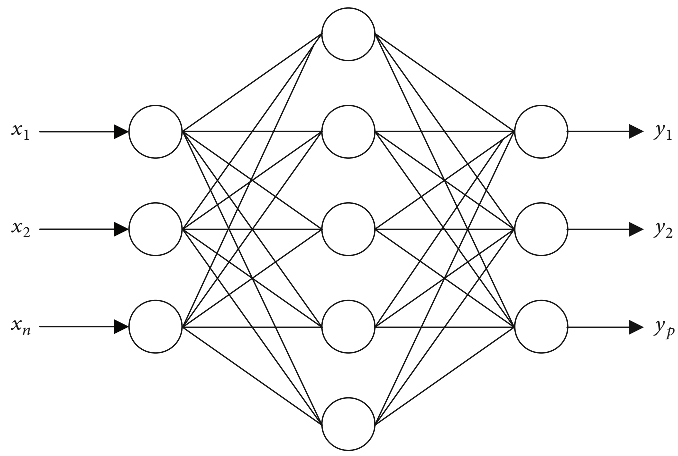

Figure 1: The BP network.

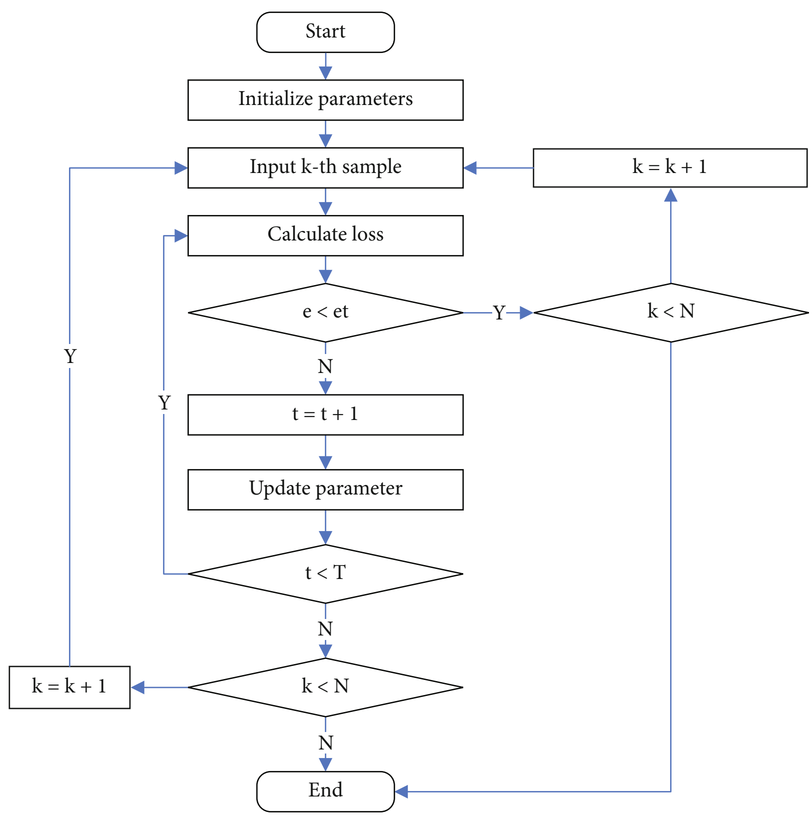

Figure 2: The pipeline of BP.

If state X_b is better than state X_a, the fish moves one step towards this state. If state X_b is not better than state X_a, keep trying to select a new state. Repeatedly try a certain number of times; if the foraging conditions are still not met, move one step randomly.

In order to survive in groups and minimize harm, fish have evolved a natural tendency to gather in groups. It is a typical gregarious behavior that fish individuals gather in groups. It is generally believed that fish individuals do not need to have a leader in the group to organize. As long as each fish follows the guidelines within the group, then the clustering phenomenon emerges as a global pattern from the local interactions of the individuals.

In AFSA, the following regulations are made for each artificial fish: one is to move each individual to the center of the adjacent individual as much as possible, and the other is to avoid excessive clustering. Set current state for artificial fish as X_a, search for partners in the current neighborhood,

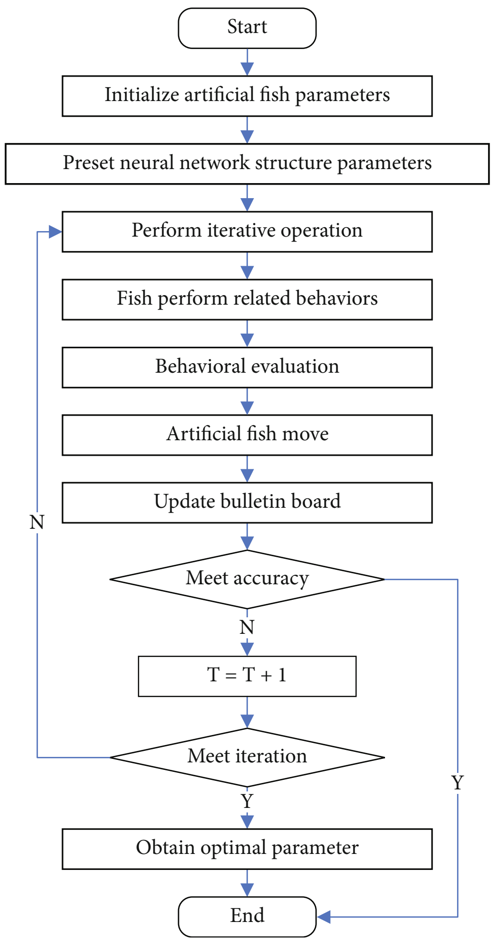

Figure 3: Network optimization process.

Table 1: The feature index for each sample.

Index	Item
a_1	Product story
a_2	Cultural connotation
a_3	Brand
a_4	Package design
a_5	Symbol of taste
a_6	Ergonomics
a_7	Interface design
a_8	Technological advancement
a_9	Interaction fluency

and find out center position.

$$X_C = \frac{\sum_{i=1}^{N} X_i}{N}. \quad (6)$$

When the centers of other partners of the current artificial fish have more food and are not too crowded, they can move one step toward the center of the partners; otherwise, perform foraging behavior.

Due to nature for food tendencies, when an individual in a fish group finds food, other individuals attached to the fish will instinctively swim towards the fish, forming a group that follows the group. Artificial fish engage in tail-chasing behavior, which is a pursuit of the most fit of the nearby artificial fish. Moving towards the best neighboring state in an optimization procedure is what this term refers to. Set current state as X_a, search for partners in the current neighborhood, and the partner X_b with the largest fitness value among the partners. If the partner in state X_b has a high food concentration and there is still room to continue clustering, move one step towards partner X_b; otherwise, perform foraging behavior.

On the surface, individual fish swimming freely in the water is aimless; in fact, they are searching for possible food and companions in the wider space around themselves. The description of the random behavior is relatively simple; it randomly selects a state and moves one step toward the state.

The field of view and the step size of the artificial fish are fixed in the basic artificial fish swarm algorithm. Step size and field of view determine the fake fish's search range as well as its convergence speed and accuracy. The artificial fish swarm algorithm's full potential is limited by a constrained field of vision and step size, resulting in low precision of the optimal solution and a slow convergence rate.

When artificial fish have a small field of perception, their behavior is dominated by foraging and randomness. The tail-chasing habit of the fake fish becomes more prominent when the fish's field of view is expanded. The artificial fish can be prompted to locate the global optimal solution earlier in the algorithm via a wider range of view. An algorithm can now fast reach convergence by moving toward an ideal solution with a bigger step size. With a high degree of certainty, artificial fish swarm around the ideal solution in the last stage of the algorithm. As long as the fake fish cannot forage efficiently because their field of view is too wide, they will wander towards areas with higher concentrations of food. An adaptive piecewise technique is therefore created to increase the step size of artificial fish. The artificial fish adapts its range of view and step size as the algorithm is run, first increasing them and then decreasing them as the algorithm is run.

$$v_a = v * \frac{k_v}{t^{t_v}}. \quad (7)$$

As the algorithm progresses, the artificial fish's increased vision field expands, helping the fish locate the global ideal solution. The artificial fish's field of view adapts to the amount of algorithm iterations. Foraging and random behavior in artificial fish are more likely when the field of view is reduced adaptively, which aids in local search and boosts foraging success rates.

In order for the algorithm to quickly converge, the artificial fish must be able to move over a greater area. When using an algorithm, it is important to remember that if the step size is too large, the artificial fish may cross over the maximum concentration of food, which will reduce the number of results returned. The small step size is favorable to the local search of artificial fish, but the search speed is slow, and it is easy to get stuck in the local optimum. To boost the global search ability,

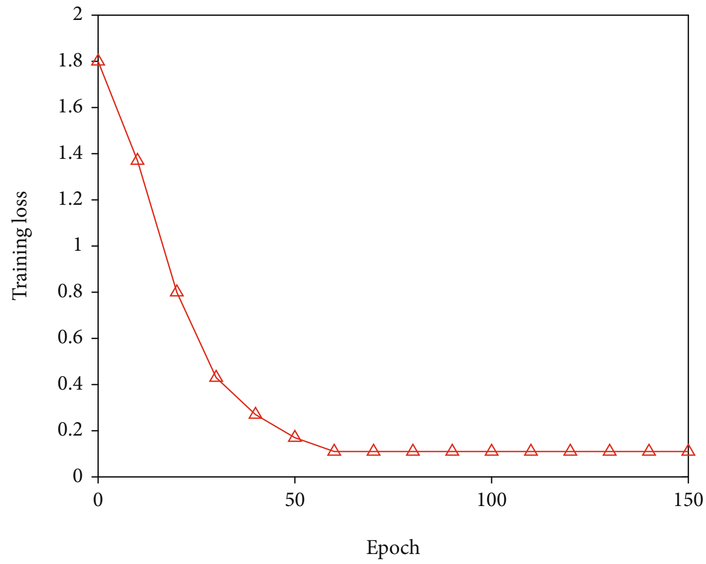

FIGURE 4: The training loss.

TABLE 2: Evaluation with other methods.

Method	Precision	F1
Linear regression	85.5	81.2
Logistic regression	87.6	83.6
SVM	91.2	88.9
IAFSA-BP	94.6	93.2

a big step size for the artificial fish is used in the early stages of the algorithm. This allows for a faster movement toward the best solution and a more efficient gathering of artificial fish near the optimal solution. In order to help the artificial fish get closer to the optimal solution, the step size is reduced. The algorithm thus runs with lower error rates which improves the system's ability to perform local searches later on.

$$s_a = s * \frac{k_s}{t^{t_s}}. \tag{8}$$

The artificial fish quickly converges to the ideal solution by increasing the step size at the beginning of the iteration. The attenuation effect becomes more pronounced as the number of iterations of the algorithm grows, and the step size decreases. Sophisticated adaptive attenuation strengthens the local search and improves the solution's correctness. The improved algorithm's performance is heavily influenced by its parameter selection. This can cause the algorithm to be premature, fall into a local optimum, or fail to converge when the decay index is too big.

The advantage of IAFSA over AFSA lies in its adoption of dynamic adjustments for the view and step length of artificial fish. This allows it to hold a large value during the early stage of the algorithm. This value changes from big to small wherein the transformation from rough search to refined search is conducted. Secondly, the algorithm allows the artificial fish to traverse to more appropriate positions during the foraging, bunching, and performing rear-end behaviors. This eliminates the chances of unnecessary and repeated searching of same region in order to feed. This introduces decay factor removing uncertainties relevant to search regions which speeds up the convergence. Finally, the strategy to update the call-board is improved wherein the food density in the previous position is compared with that of the other partner fishes in the group in the nearby region. This helps to identify and guide the group towards better direction.

3.3. BP Network Optimization with IAFSA. While the BP network shows its great advantages in the application process, its defects are also constantly emerging. The algorithm process of BP network still has the following shortcomings. (1) Local optimum problem: nonlinear and linear mappings are both possible with the multilayer BP network. There are many reasons why BP networks may fail in actual applications, including the randomness of initial parameter selections and the wide range of application domains in which they can be used. It is necessary to retrain the network and reinitialize its settings several times until the error performance function of the BP network reaches a local minimum before trying again until a good solution is reached. (2) The coordination issue of stability as well as learning rate: in theory, if the network can learn stably, a smaller learning rate is used. Although the network learning is very stable, the learning speed may be very slow or even unacceptably slow, resulting in the system having no practical value. Because the method is steady, the learning rate should be as high as possible. Because of its high learning rate and stability, the additional momentum technique is faster than the standard gradient algorithm in terms of learning speed, but it is still not fast enough to meet the requirements of fast and efficient. (3) The selection criteria of the learning rate are

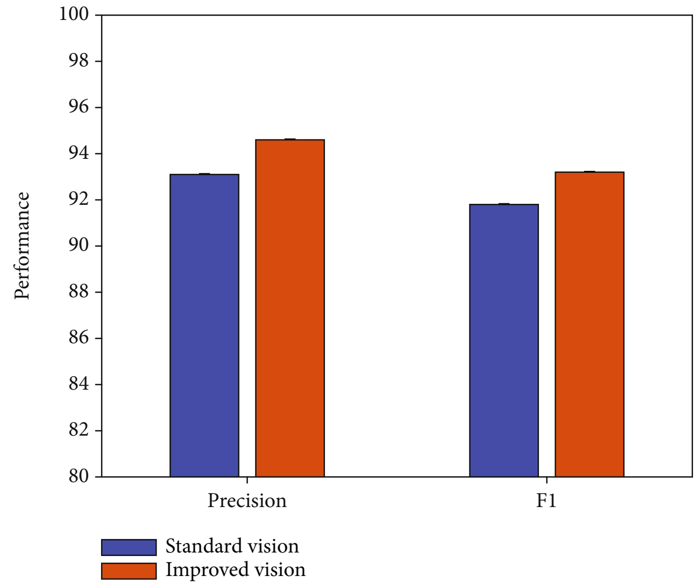

Figure 5: Evaluation on improved vision.

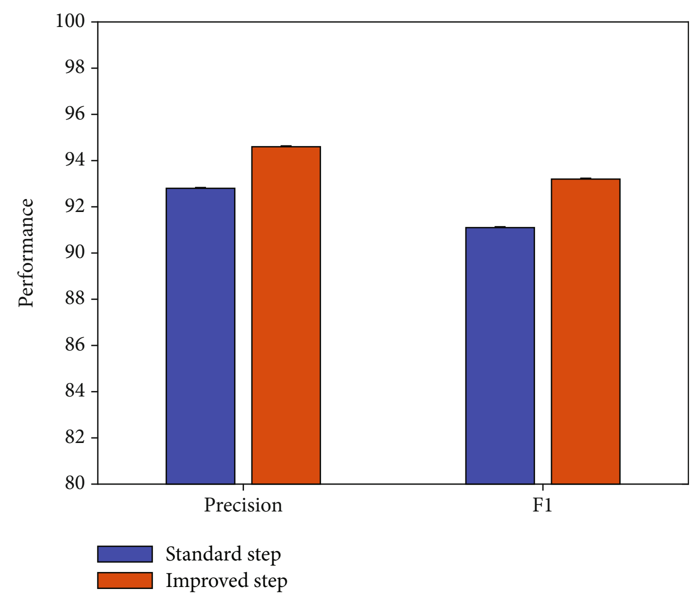

Figure 6: Evaluation on improved step.

uncertain: it is difficult to determine the learning rate of nonlinear network, and a simple and feasible method has not been found to solve the problem of learning rate selection. (4) The issue of choosing neurons in the hidden layer: there is currently no established theoretical basis for determining the optimal number of neurons to include in a multilayer neural network's hidden layer. Having too few neurons in the hidden layer may make it difficult for the network to be properly trained and hence inaccurately diagnose. The network may encounter too much repetition of information if there are too many neurons in the buried layer.

This work uses the IFASA to optimize BP network. The specific optimization process is illustrated in Figure 3.

4. Experiment and Discussion

4.1. Dataset. This work uses a self-made dataset for experiments, which contains a total of 15,827 samples, including 10,383 training samples and 5,444 test samples. The feature indicators of each sample are shown in Table 1, and the label of each sample is the corresponding aesthetic value rating.

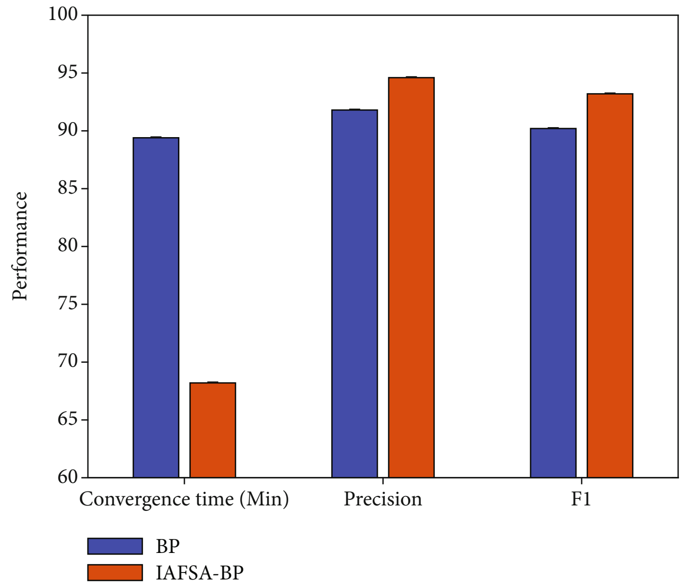

Figure 7: Evaluation on IAFSA-BP.

4.2. Evaluation on Training Loss. This work firstly evaluates the training process of the IAFSA-BP network and mainly analyzes the loss changes during the network training process to preliminarily evaluate the correctness of the network model. The experimental result is illustrated in Figure 4.

As the network is trained further, the loss first gradually decreases. When epoch = 60, the model loss does not change, which means that the network has converged at this time and can better fit the training data. This also preliminarily proves the effectiveness of this method.

4.3. Evaluation with Other Method. To further verify the effectiveness of the IAFSA-BP method, it is compared with other machine learning methods. The methods compared include linear regression, logistic regression, and SVM. The experimental result is illustrated in Table 2.

The method proposed in this work can achieve the best evaluation performance. Compared with the best performing methods in the table, 3.4% precision improvement and 4.3% F1 improvement can also be obtained, thus proving the effectiveness and feasibility of the IAFSA-BP method.

4.4. Evaluation on Improved Vision. This work improves the field of view mechanism in the AFSA algorithm. In order to verify the effectiveness of this improved strategy, this work compares the network performance when using the standard field of view and the improved field of view. The experimental result is illustrated in Figure 5.

Compared with the traditional field of view mechanism, when it is improved, 1.5% precision improvement and 1.4% F1 improvement can be obtained. This can prove the correctness of this work to improve the visual field.

4.5. Evaluation on Improved Step. This work improves the step mechanism in the AFSA algorithm. In order to verify the effectiveness of this improved strategy, this work compares the network performance when using the standard step and the improved step. The experimental result is illustrated in Figure 6.

Compared with the traditional step mechanism, when it is improved, 1.8% precision improvement and 2.1% F1 improvement can be obtained. This can prove the correctness of this work to improve the step.

4.6. Evaluation on IAFSA-BP. To verify the correctness of applying the improved AFSA to the BP network optimization in this work, it is compared with the standard BP network, and the experimental result is illustrated in Figure 7.

Compared with the traditional BP network, after using the IAFSA-BP algorithm, the convergence time of network training is significantly reduced, and the network performance is improved. This proves the correctness of applying IAFSA to BP network optimization in this work.

5. Conclusion

The cultural and creative industry first sprouted from the reform and opening up, and with the development of the market economy and the rapid development of the government, it has gradually become an important growth point supporting economic development. In the context of the rapid development of digital technology and the ever-changing digital media, digital technology gives cultural and creative product design more possibilities, while digital media gives cultural and creative products a broader space for creativity and expression. Since the birth of the Industrial Revolution, the aesthetics of cultural and creative products has attracted the attention of many scholars and enterprises. Social practice has proved that aesthetic value is an integral part of a successful product; it is not only an added value but also a spokesperson for product and brand quality. It is an effective way to solve problems for today's digital cultural and creative products by showing the traditional Chinese connotation in digital cultural and creative products and creating beauty for design with unique charm of traditional aesthetics. In this context, how to realize the aesthetic value evaluation of digital cultural and creative products has become a very important topic. Based on neural network, this work designs an improved BP network to evaluate the aesthetic value of digital cultural and creative products. First, the basic idea, structural characteristics, learning algorithm, and algorithm flow of BP network are analyzed. Establish an aesthetic value evaluation model of digital cultural and creative products based on BP network. Secondly, a segmentation adaptive strategy is designed to improve the field of view and step size of the individual artificial fish. It solves the problem that the optimal solution accuracy of the artificial fish swarm algorithm is not high, and the convergence speed of the algorithm is reduced in the later stage. The algorithm verification results show that the optimal solution accuracy and convergence efficiency are improved. The improved fish swarm algorithm is applied to the optimization of the BP network structure, and the simulation results show that the performance of the optimized BP network is significantly improved. The model is evaluated based on the metrics precision and F1 score which could be improved by inclusion of other metrics. Hence, as part of future study, the model could be evaluated against the other traditional and state-of-the-art approaches based on accuracy, precision, specificity, sensitivity, F1 score, and various others.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The author declares that he has no conflict of interest.

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