www.cad-journal.net
Computer-Aided Design AND APPLICATIONS

Design and Implementation of Automatic Generation Algorithm for Advertising Artistic Design Based on Neural Networks

Qi Li[1] and Ertao Zhou[2]

[1]School of Art and Design, Zhengzhou College of Finance and Economics, Zhengzhou, Henan 450000, China, liqi@zzife.edu.cn
[2]School of Art and Design, Zhengzhou College of Finance and Economics, Zhengzhou, Henan 450000, China, zhouertao@zzife.edu.cn

Corresponding author: Qi Li, liqi@zzife.edu.cn

Abstract. With the growth of AI, especially breakthroughs in artificial intelligence technology, designers can use machine learning algorithms to generate advertising artistic designs automatically. Traditional grid search and random search methods require a large amount of computational resources and time costs, while particle swarm optimization (PSO) algorithms can find better combinations of hyperparameters in a shorter period of time. This article proposes a current neural network (RNN) algorithm based on PSO, combined with computer-aided design (CAD) tools, to be applied to the automation generation and optimization of advertising artistic design in order to improve design efficiency. By combining the RNN algorithm with CAD tools, designers can automatically generate advertising designs through the algorithm and then adjust and output them through CAD tools. The results show that the PSO-based RNN algorithm can generate more diverse shapes, colours, and textures, demonstrating high novelty and innovation. Moreover, the correlation and overall coordination between various design elements have also been significantly enhanced.

Keywords: CAD; Neural Network; Advertising Artistic Design; Automatic Generation
DOI: https://doi.org/10.14733/cadaps.2024.S18.114-127

1 INTRODUCTION

In the current advertising design field, designers usually do manual design, and the design quality is often influenced by the designer's personal experience. In today's digital and intelligent world, Software defect prediction has become a key link in ensuring software quality and user experience. However, traditional software defect prediction methods often face problems such as low accuracy and poor generalization ability. To address these issues, Anju and Judith [1] proposed an adaptive recurrent neural network model based on the quantum theory particle swarm optimization algorithm for predicting defects in advertising software. This model improves the performance of neural networks and achieves accurate prediction of software defects by combining quantum computing and

particle swarm optimization algorithms. This network can automatically adjust the network structure and parameters based on the characteristics of input data by introducing an adaptive mechanism, achieving efficient processing of complex data. In advertising software defect prediction, adaptive recurrent neural networks can automatically extract defect features and patterns through learning from historical defect data, achieving accurate prediction of future defects. Designers can automatically generate advertising artistic designs through machine learning algorithms. With the rapid development of technology, deep learning technology has provided new possibilities for the innovative application of ink painting. Chen [2] explored how to combine deep learning frameworks with CAD (Computer Aided Design) neural network models for the creation and exploration of ink painting art advertisements. Deep learning frameworks are the fundamental platforms for implementing deep learning algorithms, such as TensorFlow, PyTorch, etc., providing powerful computing power and flexibility. The CAD neural network model is an algorithm that simulates design decisions, which can automatically generate artistic advertising designs. Using deep learning frameworks, train CAD neural network models to extract features and styles from ink paintings. By combining the artistic style of ink painting with advertising design, the transfer of ink painting art in advertising creation can be achieved. Automatically generate advertising designs with ink painting art style using trained CAD neural network models by continuously adjusting model parameters and optimizing algorithms to verify the effectiveness of the ink painting art advertising creation method frameworks and CAD models. The results show that this method can generate advertising designs with an ink painting art style, and it also has good commercial effects while ensuring artistic quality, which can adapt to the creative needs of different themes and advertising forms. With the growth of deep learning (DL), neural networks and other technologies, machines can learn and simulate the complex behaviour of human beings and then create innovative and artistic works.

As a field that needs constant innovation and personalized demand, advertising artistic design has also begun to explore how to use these advanced technologies to improve the design level. Flower products have a unique appeal in social media advertising, as their beautiful colours and unique forms often attract the attention of consumers. However, it is worth exploring how to effectively utilize the automatic generation technology of advertising art design using CAD and neural networks to create more attractive social media advertisements for flower products. Corry et al. [3] explored how to test the automatic generation of social media advertising strategies for flower product CAD and neural network advertising art design. The automatic generation technology of advertising art design using CAD and neural networks automatically generates creative and attractive advertising design schemes through computer-aided design software and neural network models. This technology can help designers quickly generate diverse advertising design solutions and improve design efficiency. In social media advertising of flower products, CAD and neural network advertising art design automatic generation technology can be used to integrate the beautiful colours and unique forms of flowers into advertising design, creating more attractive advertising works. Using CAD and neural networks to generate advertising design solutions: Using CAD and neural network technology, incorporating floral materials into advertising design to generate creative and attractive advertising design solutions. Publish the generated advertising design plan on social media platforms, observe audience reactions and feedback, and evaluate the effectiveness of the advertisement. The application of CAD and neural networks in advertising art design has become increasingly widespread. CAD can assist designers in precise layout, image processing, etc., while neural networks can automatically extract features and new design solutions by learning from them. In fashion advertising design, CAD and neural networks can combine fashion elements, brand characteristics, etc., to generate creative and attractive advertising design solutions. Ikhlef and Awad [4] explored the gender representation of advertising art design automatic generation using CAD and neural networks in social media fashion advertisements and applied multimodal discourse analysis methods for analysis. Gender representation in social media fashion advertisements is a noteworthy issue. In traditional fashion advertisements, female images are often portrayed as weak, dependent, and housewife, while male images are portrayed as strong, independent, and successful in their careers. However, with the progress of society and changes in attitudes, more and more women are pursuing independent, autonomous, and equal lifestyles, while men are also paying attention to their

appearance and image. Painting advertising has a unique artistic style and aesthetic value. However, traditional painting advertising style feature extraction methods often face problems such as low accuracy and poor efficiency. To address these issues, Jiang and Yang [5] proposed convolutional neural networks, aiming to achieve efficient and accurate style feature extraction, providing strong support for the creation and design of painting advertisements. It automatically learns the features and patterns in images by simulating the connection of human brain neurons, achieving efficient recognition and understanding of images. In the extraction of advertising style features in painting, convolutional neural networks can automatically extract style features from advertising images, such as colour, strokes, composition, etc. Train the convolutional neural network model using training data to learn the style features of painting advertisements automatically. After training, the model can be used to extract style features from new painting advertising images. Visualize the extracted style features for easy analysis and understanding. Meanwhile, these features can be utilized for further advertising design and creation. Computer-aided design software can create complex 3D models and build virtual environments. Designers can lay out and combine elements for advertising design in this virtual environment, achieving more intuitive and efficient design. Designers can create dynamic effects and interactive designs, making advertisements more attractive and interactive. For example, showcasing the characteristics and advantages of a product through animation effects or attracting user attention through interactive design. Computer-aided design software can help designers quickly generate advertising design solutions through automated generation and optimization algorithms. This greatly shortens the design cycle and improves work efficiency. Jin and Yang [6] discussed the automatic generation of virtual environment art advertising art design. Through computer vision technology, feature information can be extracted from images or videos to generate advertising design schemes with similar features. This automatic generation method can quickly generate a large number of design proposals, providing designers with more choices. Designers can use these features and patterns to guide the automatic generation of advertising design schemes. Deep learning technology can also achieve more complex and refined advertising design automatic generation by training neural network models. Computer-aided design (CAD) and neural network technology advertising art design. For students majoring in advertising art and design, mastering these technologies and applying them to graphic design is the key to improving their competitiveness and innovation ability. Kimani et al. [7] explored how CAD and neural networks can be enhanced. CAD can easily draw various shapes and lines, including geometric shapes, text, images, etc. Designers can use CAD to create various elements of advertising design. CAD provides precise size and layout tools, allowing designers to accurately arrange the position and size of advertising elements. CAD provides rich colour and style editing tools, allowing designers to view and adjust the design effects of advertisements on their computers in real-time. A neural network is a computational model that simulates the connectivity of human brain neurons, which can be trained, learned, and automatically optimized for design. Incorporate CAD and neural network-related courses into the curriculum system of advertising art and design majors, enabling students to systematically learn and master these technologies. Through practical project training, students are encouraged to apply theoretical knowledge to practical design projects, cultivating their practical abilities in using CAD and neural networks for graphic design. By collaborating with the advertising industry, students can be exposed to real-life design projects and learn about the latest technological trends and design trends in the industry.

How to enable computers to generate artistic advertising designs automatically remains a challenging issue. Therefore, this article proposes an RNN algorithm based on PSO. RNN is a commonly used neural network for processing sequence data, which can learn and simulate long-term dependencies in sequence data. By training RNN models, computers can learn the inherent laws and patterns of advertising design, thereby automatically generating new designs. The PSO algorithm is a commonly used global optimization algorithm that can effectively solve parameter optimization problems in RNN models. This study also combines the PSO-based RNN algorithm with CAD tools to achieve automated generation and optimization of advertising artistic design. CAD tools are commonly used CAD software that can assist designers in efficient and accurate design. By combining the RNN algorithm with CAD tools, designers can automatically generate advertising

designs through the algorithm and then adjust and output them through CAD tools. This can not only improve the efficiency of designers and reduce their workload but also make the design results more in line with market demand and user preferences through the optimization function of algorithms.

Innovation Points:

(1) This article combines the PSO algorithm with RNN and utilizes DL technology to enable computers to learn and generate advertising artistic designs automatically.

(2) By training RNN models, computers can learn the inherent laws and patterns of advertising design, thereby automatically generating new designs. The PSO algorithm solves the parameter optimization problem in RNN models.

(3) This article combines the RNN algorithm based on PSO with CAD tools to achieve automated generation and optimization of advertising artistic design. Designers can use CAD tools to finely adjust and output automatically generated designs.

This article first introduces the research significance of the automated generation of artistic advertising design. Then, it provides an overview of relevant technologies and theories. Based on this, a PSO-based RNN algorithm is proposed and integrated with CAD tools for application. Next, analyze the results and discuss the practicality of the method proposed in this article. Finally, summarize the research findings and future work.

2 OVERVIEW OF RELEVANT TECHNOLOGIES AND THEORIES

Artificial intelligence and neural networks have become the focus of innovation in many fields. Contemporary art advertising graphic design is no exception, exploring how to use neural network technology to enhance the innovation and expressiveness of design. Liu and Yang [8] discussed contemporary art advertising print models centered on neural network innovation. Through training and learning, it can automatically extract features and patterns from data in advertising graphic design, image generation, and other aspects to help designers achieve automated and innovative design. Deep learning techniques can learn image data and extract features and patterns from images. Generative adversarial networks can generate new images with structures and styles similar to training data but with novelty. These technologies can help designers quickly generate diverse advertising design solutions and improve design efficiency. Image semantic segmentation technology can classify and segment different elements in an image. Meanwhile, by using techniques such as generative adversarial networks and variational autoencoders, new image elements can be generated based on the results of semantic segmentation, providing more creative possibilities for advertising design.

As an important component of the advertising industry, painting advertising has a unique artistic style and aesthetic value. However, traditional painting advertising style feature extraction methods often face problems such as low accuracy and poor efficiency. To address these issues, Liu et al. [9] proposed painting advertising styles based on convolutional neural networks. Intended to achieve efficient and accurate style feature extraction, providing strong support for the creation and design of painting advertisements. Based on the style characteristics of painting advertisements, construct a suitable convolutional neural network model, convolutional neural network model, using training data to automatically learn the style features of painting advertisements. After training, the model can be used to extract style features from new painting advertising images. Visualize the extracted style features for easy analysis and understanding. Meanwhile, these features can be utilized for further advertising design and creation. Image classification technology has special significance for the research and protection of cultural heritage. Milani and Fraternali [10] discussed how to use computer-aided design (CAD) and neural network technology to classify painting images and conducted in-depth research and understanding of cultural heritage through computational datasets and convolutional models. To train an effective image classification model, we need a large-scale and diverse dataset. This dataset should include various painting styles, themes, periods, and works of artists. We can complete this dataset by scanning books, digitizing artworks, and obtaining images

from public and private collections. After creating the dataset, we need to use CAD software to preprocess the images, such as size standardization, colour correction, etc., to improve the training effect of the model. By using CAD and neural network-based painting image classification techniques, we can delve deeper into the study of cultural heritage. For example, we can analyze the evolution of artistic styles or classify the personal styles of artists. In addition, we can gain heritage by comparing art styles from different cultures or periods.

Digital marketing communication in advertising effectiveness. The millennial and Z generations, as the current mainstream consumer groups, have higher requirements for digital marketing communication and advertising effectiveness. The automatic generation technology of advertising art design using CAD and neural networks provides new possibilities for digital marketing communication. Munsch et al. [11] explored the application of automatic generation of advertising art design using CAD and neural networks in digital marketing communication and advertising effectiveness for the millennial and Z-generation and conducted in-depth exploration using qualitative research methods. The automatic generation technology of advertising art design using CAD and neural networks can be combined with big data analysis to deeply explore consumer interests, habits, and other information, providing more accurate positioning and creativity for advertising design. For example, by analyzing the interactive behaviour and content preferences of millennials and Generation Z on social media, targeted advertising ideas can be generated through image processing, and advertising art analysis is becoming increasingly widespread. Pinciroli et al. [12] explored algorithms to recognize salient image features in image advertisements and compared the performance of different neural algorithms. Image advertising is modern advertising. In order to attract the attention of the audience and convey advertising information, image advertising needs to have some significant image features, such as bright colours, unique textures, eye-catching shapes, etc. LSTM can be used to analyze advertising video information. By converting video frames into vector representations, LSTM can capture dynamic features in videos and analyze the narrative structure and visual style of advertisements. By comparing the applications of different neural algorithms in image advertising art analysis, we can find that different neural algorithms have different advantages and applicable scenarios. CNN is suitable for extracting image features, RNN is suitable for processing text information, and LSTM is suitable for analyzing video information. In practical applications, we can choose appropriate neural algorithms based on specific needs to achieve.

Handwritten script recognition aims to convert handwritten text into computer-readable text. Traditional handwriting script recognition methods are mainly based on feature extraction and pattern recognition. However, these methods often face difficulties in feature extraction and low accuracy in pattern recognition when dealing with complex handwritten scripts for art advertisements. Therefore, Sharma et al. [13] proposed applying convolutional neural networks to handwritten script recognition in art advertisements. Collect a large number of handwritten script images of art advertisements from advertising creativity, covering features such as different fonts, sizes, and colours. Then, we preprocess these images, such as grayscale and binarization, to reduce the uncertainty of the data. Finally, we construct a large-scale art advertisement handwritten script dataset for training and testing our model. In the field of digital marketing, the click-through rate of display advertisements is a key indicator for measuring advertising effectiveness. In order to increase click-through rates, advertisers and marketers constantly explore and try various strategies and technologies. Reinforcement learning is a machine learning technique that simulates the decision-making process to learn how to optimize decisions to maximize the objective function. Singh et al. [14] explore how to apply reinforcement learning to optimize display ad clicks in digital marketing and how to design effective reinforcement learning algorithms to improve ad clicks. Reinforcement learning has broad application prospects in digital marketing, including search engine optimization, recommendation systems, advertising placement, and other fields. In the field of display advertising, reinforcement learning can be applied to optimize advertising placement strategies, automatically adjusting advertising placement strategies by learning historical data and user behaviour to maximize click-through and conversion rates. State space is the input information for decision-making in reinforcement learning. In optimizing the click-through rate of display

advertisements, the state space should include features related to the advertisement and user-related features, such as the title, image, content, and other information of the advertisement, as well as user browsing history, interest preferences, and other information. Action space is the output information of decision-making in reinforcement learning. In optimizing the click-through rate of display advertisements, action space can include adjusting the exposure frequency and display position of advertisements.

This technology not only provides architects with more creative possibilities but also opens up new avenues for artistic inheritance. Xu et al. [15] use digital sculpture technology to carve and shape it meticulously. This technology not only allows designers to easily create sculpture works with various complex shapes and textures but also provides a more efficient and accurate way for the production and replication of sculpture works. The emergence of digital sculpture technology has not only changed the creative methods of traditional sculpture art but also provided artists with more creative possibilities and expressions. At the same time, it also provides a more convenient way for the production and circulation of sculpture works, allowing more sculpture works to be appreciated and collected by more people. For example, through digital sculpture technology, designers can simulate the structures of traditional buildings, such as beams, columns, eaves, etc., in order to better understand their aesthetic and structural characteristics. Meanwhile, digital sculpture technology can also help designers create novel architectural forms with traditional elements, thereby achieving a perfect combination of tradition and modernity. The way information is transmitted, and the way people receive it are undergoing profound changes. The traditional advertising design methods can no longer meet the needs of modern society. The emergence of CAD and neural networks has brought new possibilities for the automatic generation of advertising art design. Interactive design can better attract the audience, involve them in the advertisement, and further enhance the effectiveness of the advertisement. Zhong et al. [16] explored the automatic generation of advertising art design using CAD and neural networks. The application of CAD and neural networks in advertising art design has become increasingly widespread. CAD can assist designers in precise layout, image processing, etc., while neural networks can automatically extract features and new design solutions by learning from them. In the new media environment, the application of CAD and neural networks will be more in-depth. For example, neural networks can be used to generate advertising design schemes with specific themes and then fine-tune and optimize them through CAD. The characteristics utilized to integrate interactive design into advertisements allow the audience to participate and enhance the interactivity and fun of advertisements.

3 DESIGN OF RNN ALGORITHM BASED ON PSO

3.1 Design and Construction of RNN Model

RNN has cyclic connections, which can transmit information from the previous moment to the next moment, thereby capturing dynamic patterns and long-term dependencies in sequence data. In art and design, the application of RNN is reflected in generating design elements and style transfer. RNN can generate new design elements and patterns by learning from existing design datasets. In graphic design, RNNs can learn and simulate different combinations of lines, shapes, and colours to generate new graphics with unique styles. RNN can be used for style transfer, which involves applying one design style to another. By training two RNN models with different styles, the generative ability of one model can be utilized to transfer the style of the other model to a new design. The PSO algorithm is an optimization algorithm that seeks the optimal solution to a problem by simulating the behaviour of biological populations such as bird and fish populations. In DL, the PSO algorithm is mainly used for hyperparameter optimization and model selection in neural networks. The performance of neural networks is often affected by hyperparameter settings, such as learning rate, batch size, regularization coefficients, etc. Traditional grid search and random search methods require a large amount of computational resources and time costs, while PSO algorithms can find better combinations of hyperparameters in a shorter period of time.

In addition to hyperparameter optimization and model selection, the PSO algorithm can also be used in the training stage of neural networks. For example, optimizing the weights and biases of neural networks as particles and finding the optimal solution. CAD tool is a software tool widely used in engineering design, architectural design, product design and advertising design. CAD tools can help designers draw, edit, and modify graphics efficiently and provide rich design resources and tool libraries to support designers' creativity and design work. In advertising design, CAD tools can help designers quickly draw and edit design elements such as graphics, words and images. Moreover, CAD tools provide rich functions such as filters, special effects and animations, which can help designers create more vivid and interesting advertising design works. RNN has a natural advantage in processing time series data due to its memory. In order to fully utilize the characteristics of RNN, this section designs an advertising artistic design generation model based on RNN. Choose Long Short Term Memory Network (LSTM) as the basic structure of RNN, as it can solve the gradient vanishing problem of traditional RNN when processing long sequences. LSTM can retain information in long-term memory and selectively forget and update it when needed by introducing memory units and gating mechanisms. Thus, possessing dynamism and memory ability enables accurate prediction. Figure 1 shows the unfolded RNN structure.

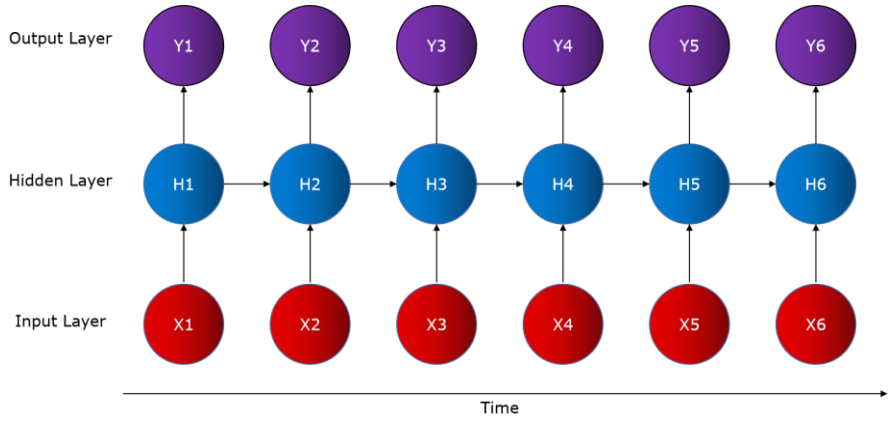

Figure 1: Expanded RNN structure.

The input of the model is a sequence of design elements, such as lines, shapes, and colours, and the output is the next predicted design element. This setting enables the model to generate new design elements according to existing design elements. In this article, several hidden layers are designed, and LSTM memory cells are used in each hidden layer. This can increase the complexity of the model and enable it to capture richer design patterns and styles.

$$h_t = \varphi(Ux_t + Wh_{t-1} + b) \tag{1}$$

The output at time t is related to the state h_t of the hidden layer at time t:

$$o_t = Vh_t + c \tag{2}$$

Where c represents offset. The final output of the model is:

$$\hat{y}_t = \sigma(o_t) \tag{3}$$

Among them σ is the activation function.

In the construction stage of the model, it is implemented by using the DL framework TensorFlow. By defining input, output, hidden layer, memory cell, loss function, and optimizer, a complete RNN model is constructed. Then, a large quantity of design element sequence data is used to train the

model so that it can learn the inherent law of design. As shown in Figure 2, the framework principle of depth RNN is in this article.

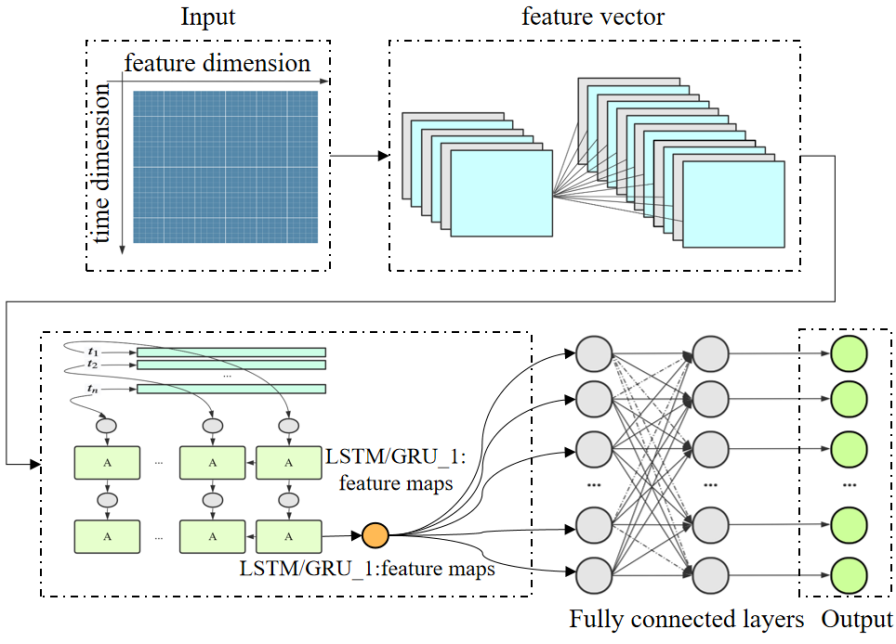

Figure 2: Depth RNN architecture.

$$h = \sqrt{M \times N} \tag{4}$$

$$\Delta w_{ij} = \lambda x_i y_j \tag{5}$$

$$\Delta w_{ji}(n) = -\eta \sum_{t=0}^{n} a^{\eta - t} \frac{\partial \varepsilon(n)}{\partial w_{ji}(t)} = -\eta \frac{\partial \varepsilon(n)}{\partial w_{ji}(n)} - \eta \sum_{t=1}^{n} a^{\eta - t} \frac{\partial \varepsilon(n)}{\partial w_{ji}(t)}, 0 < a < 1 \tag{6}$$

$$E_p = \frac{\sum_t (t_{pi} - o_{pi})^2}{2} \tag{7}$$

3.2 Application and Implementation of PSO Algorithm

In order to further improve the generation quality of RNN models, this article introduces the PSO algorithm to optimize the parameters of the model. Firstly, the parameters of the RNN model (such as weights, biases, etc.) are used as the positions of the particles, and the loss function of the model is used as the fitness function of the particles. Then, a group of particles were initialized, and their velocity and position were iteratively updated to find the optimal solution. The corresponding optimization stage is shown in Figure 3.

The study used a vector to represent a particle with dimensions equal to the number of parameters in the RNN model. The initial position of particles is randomly generated, and the initial velocity is set to zero. At the beginning of each iteration, you need to set an initial position and velocity for each particle. These positions and speeds can be randomly initialized or based on some heuristic method. For each particle, use the RNN model to calculate its loss value at the current position. This loss value can be used as the fitness value for particles.

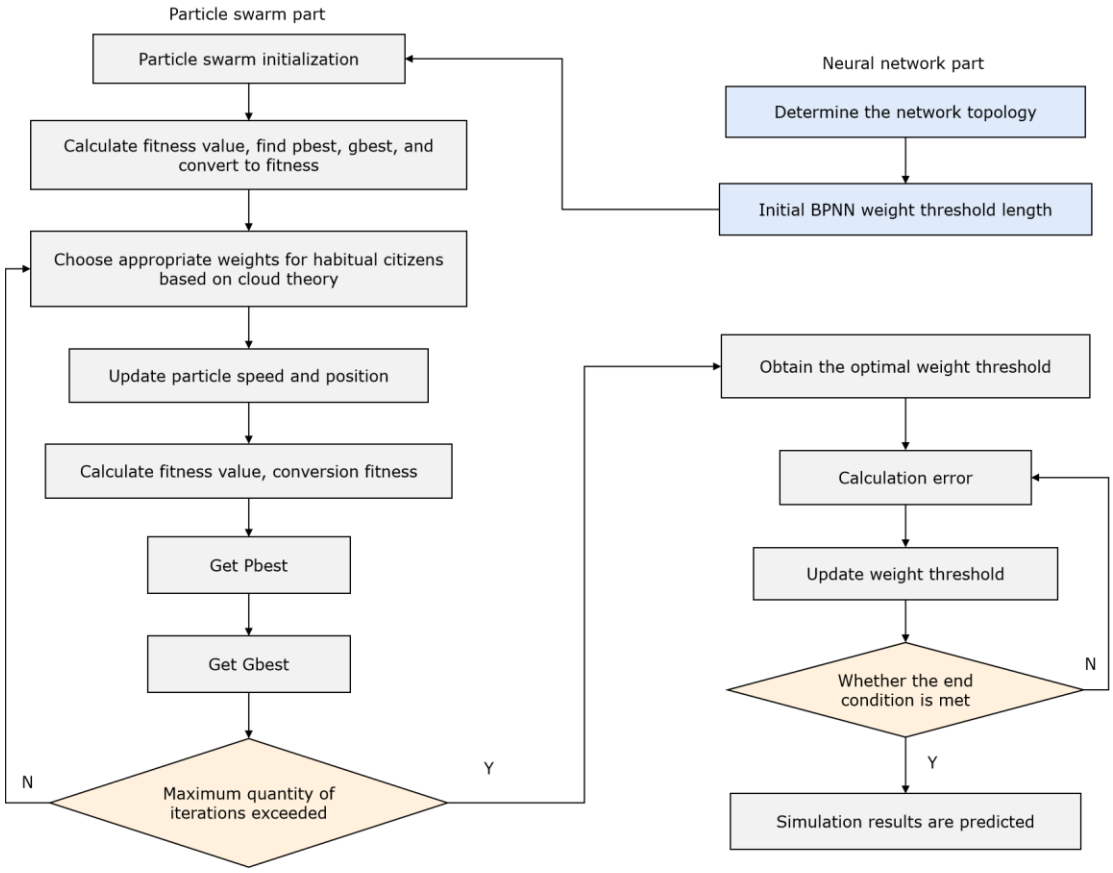

Figure 3: Optimization flow of the algorithm.

Update the velocity and position of particles based on their fitness values and those of other particles. The velocity and position of particles are updated to move in a better direction. Leverage the PSO algorithm to search for an optimal position that minimizes the below-mentioned error:

$$J = \frac{1}{n}\sum_{j=1}^{n}\sum_{i=1}^{4}(y_{ji}^{d} - y_{ji})^2 \tag{8}$$

$$y_j = \theta * f(x_j w - v) - r \tag{9}$$

The PSO algorithm can help the model find better parameter combinations, making the generated design elements more in line with the laws and styles of art and design. Moreover, it can also improve the training speed of the model by optimizing the training stage.

4 INTEGRATED APPLICATION OF CAD TOOLS

The application of CAD tools in the field of advertising art and design has been quite extensive. Its precise drawing function, rich design resources, and efficient editing ability have brought great convenience to designers. This section will explore in detail how to combine the aforementioned PSO-based RNN algorithm with CAD tools to achieve automated generation and optimization of advertising artistic design.

4.1 The Basic Functions and Characteristics of CAD Tools

The core functions of CAD tools mainly include drawing, editing, and modifying graphics. Designers can use various drawing tools, such as lines, circles, polygons, etc., to quickly draw the desired shapes. Meanwhile, CAD tools provide rich editing functions such as movement, rotation, scaling, etc., making it easy for designers to modify and adjust graphics. CAD tools have the following characteristics:

(1) Accuracy: CAD tools can provide precise drawing and measurement functions, ensuring design consistency.

(2) Rich design resources: CAD tools are usually equipped with a large number of design resources and libraries, including various graphics, textures, colours, etc.

(3) Efficient editing ability: CAD tools provide powerful editing and modification functions, which can help designers quickly complete complex design tasks.

4.2 Integration of RNN Algorithm and CAD Tools

In order to achieve automated generation and optimization of advertising artistic design, this article will integrate the RNN algorithm based on PSO with CAD tools. Firstly, prepare a large amount of advertising artistic design data. These data are used to train RNN models to learn the inherent laws of advertising artistic design. Train the RNN model using prepared data. During the training stage, the PSO algorithm is used to optimize the parameters of the model. After the RNN model training is completed, integrate it with CAD tools. Use the output of the RNN model as input to the CAD tool, enabling it to generate new design elements based on the model's predictions. By combining RNN models and CAD tools, automated generation and optimization of advertising artistic design can be achieved. Designers only need to input the basic requirements and parameters of the design, and the system can automatically generate advertising artistic designs that meet the requirements.

5 EXPERIMENTAL RESULTS AND ANALYSIS

5.1 Experimental Data and Environment

5.1.1 Experimental data

(1) Data source

In order to train and test the PSO-based RNN algorithm, this study collected advertising artistic design-related data from multiple public datasets. These datasets include advertising images, design drafts, user feedback, etc. We extract information about advertising design tasks, such as design requirements, design elements, colours, textures, etc., from these data as inputs and outputs for the algorithm.

5.2 Experimental Environment

(1) Hardware environment

The experiment was conducted on a high-performance computer. These computers are equipped with high-performance CPUs and GPUs, as well as large amounts of memory and storage space, to ensure that algorithms can be trained and tested quickly and efficiently. In addition, professional graphic processing software and CAD tools were used to better process and display data related to advertising artistic design.

(2) Software environment

In terms of the software environment, Python is used as the main programming language, and DL frameworks such as TensorFlow and Keras are used to build PSO-based RNN algorithms. In addition, data processing libraries such as NumPy and Pandas were also used for data preprocessing and analysis.

5.3 Results Display

The results showed the changes in the loss-fitting curve of the model during the initial training (as shown in Figure 4) and the last training (as shown in Figure 5). By comparing Figure 4 and Figure 5, the optimization and convergence status of the model during the training stage can be seen.

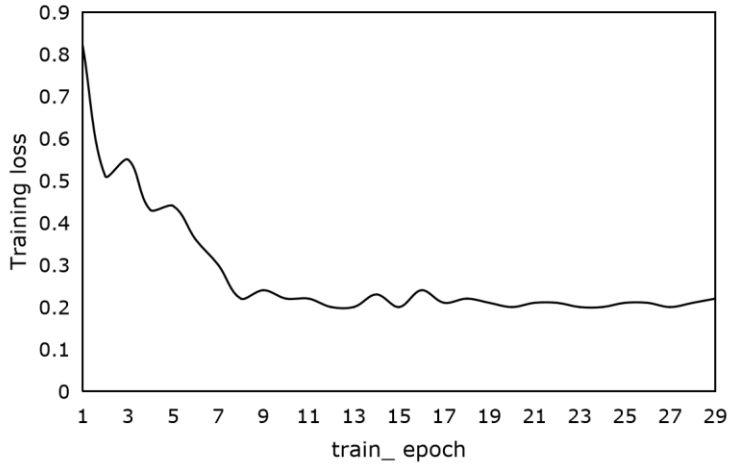

Figure 4: First training loss curve.

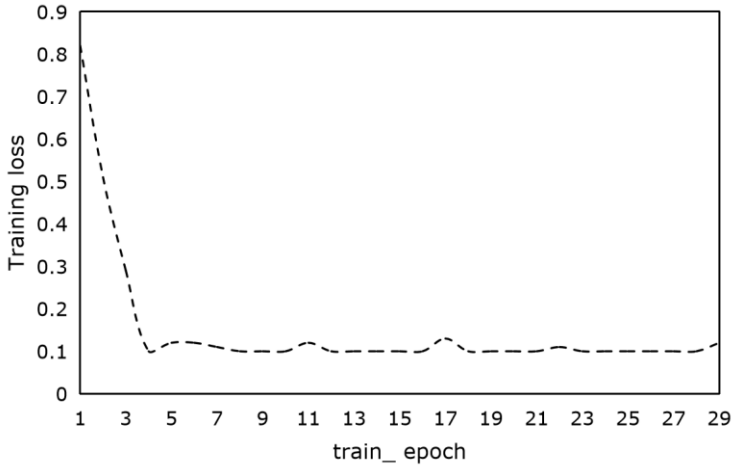

Figure 5: Loss curve of 20th training.

In the first training (Figure 4), the model's loss rapidly decreases in the initial stage, indicating that the model can quickly learn the features of the data in the early training stage, and parameter updates are effective. As the training progresses, the model gradually learns the patterns of the data, and the loss also decreases rapidly. After Epoch reaches 9, the downward trend of the loss curve tends to flatten significantly. This means that the model has already learned most of the data features, and the improvement effect of parameter updates on losses is gradually decreasing. After 20 rounds of iterative training (Figure 5), the loss-fitting curve of the model showed a faster convergence trend. This indicates that through multiple iterations of training, the model can further optimize parameters and improve its ability to fit data. In Figure 5, when Epoch reaches 4, the

model's loss has already reached a stationary state. This means that the model has gradually adjusted to a better parameter configuration in multiple iterations.

In order to verify the effectiveness of advertising art CAD generation, this study conducted an experiment using a set of advertising design tasks with different user needs. By comparing the results of graphic advertising artistic design generation based on the traditional RNN algorithm and PSO improved RNN, the algorithm was evaluated (Figure 6 and Figure 7).

Figure 6: Advertising artistic design based on traditional RNN.

Figure 7: Advertising artistic design combined with improved RNN.

The generation results of advertising artistic design based on traditional RNN algorithms can capture the basic elements and style of the design to a certain extent, but they perform poorly in terms of details and creativity. Specifically, the generated design drafts are relatively conservative in their use of graphics, colours, and textures, lacking novelty and innovation. In addition, the correlation and overall coordination between some design elements are not strong enough, resulting in a slightly dull overall visual effect. The RNN algorithm optimized by PSO has achieved significant improvement in advertising artistic design generation. The generated design drafts are more diverse and innovative in the application of graphics, colours, and textures. PSO's improved RNN algorithm has higher

novelty in advertising artistic design generation compared to traditional RNN algorithm and can provide designers with more diverse design elements. The PSO optimization process helps to improve the generation efficiency of RNN algorithms, making the generated design drafts more outstanding in terms of detail representation, correlation, and overall coordination.

5.4 Discussion

By introducing the PSO to optimize the parameters of the RNN model, this study successfully improved the quality and efficiency of model generation. The results show that the RNN model optimized by the PSO algorithm performs better in the task of advertising artistic design generation. This indicates that the PSO can optimize the parameters of the RNN model, enabling it to better learn the inherent laws of advertising artistic design.

By integrating the PSO-based RNN algorithm with CAD tools, this study achieved automated generation and optimization of advertising artistic design. The results indicate that this method can automatically generate advertising artistic designs that meet the requirements of the designer and can be optimized and adjusted based on the designer's feedback.

By comparing and analyzing the results of advertising artistic design generation between traditional RNN algorithms and PSO-based RNN algorithms, this study found that the latter is superior to the former in terms of creativity, novelty, and overall visual effect. The RNN algorithm based on PSO can generate richer and more diverse graphics, colours, and textures, demonstrating high novelty and innovation. Moreover, the correlation and overall coordination between various design elements have also been significantly enhanced.

6 CONCLUSION

Bringing infinite possibilities to advertising artistic design. This article combines the PSO algorithm with RNN and trains the RNN model to enable computers to learn the inherent laws and patterns of advertising design, thereby automatically generating new designs. In graphic design, RNNs can learn and simulate different combinations of lines, shapes, and colours to generate new graphics with unique styles. The PSO algorithm can effectively improve the RNN model and significantly improve the generation efficiency of the model in advertising artistic design generation tasks. By introducing the PSO algorithm, we can optimize the parameters of the RNN model to better learn the inherent laws of advertising artistic design. By combining the PSO-based RNN algorithm with CAD tools, it is possible to automatically generate advertising artistic designs that meet the requirements of designers and optimize them based on their feedback.

In summary, this study provides an effective automated generation and optimization method for the field of advertising art and design, promotes the cross-research between computational intelligence and advertising art and design, and provides a reference for other related fields. In the future, algorithms can be further optimized, and more applications of DL models can be explored to enhance the automation generation effect of advertising artistic design.

Qi Li, https://orcid.org/0009-0005-2098-1808
Ertao Zhou, https://orcid.org/0009-0006-6374-8624

REFERENCES

[1] Anju, A.-J.; Judith, J.-E.: Adaptive recurrent neural network for software defect prediction with the aid of quantum theory-particle swarm optimization, Multimedia Tools and Applications, 82(11), 2023, 16257-16278. https://doi.org/10.1007/s11042-022-14065-7

[2] Chen, S.: Exploration of artistic creation of Chinese ink style painting based on deep learning framework and convolutional neural network model, Soft Computing, 24(11), 2020, 7873-7884. https://doi.org/10.1007/s00500-019-03985-6

[3] Corry, R.; Taylor, W.-R.; Holt, J.; Bittles, H.; Campbell, B.-L.; Campbell, J.: Flower power: testing social media advertising strategies for floral products, Journal of Applied Communications, 107(3), 2023, 1-19. https://doi.org/10.4148/1051-0834.2485
[4] Ikhlef, A.; Awad, Z.-M.: Gender in fashion advertising on social media: a multimodal discourse analysis approach, Theory and Practice in Language Studies, 13(7), 2023, 1801-1809. https://doi.org/10.17507/tpls.1307.25
[5] Jiang, H.; Yang, T.: Research on the extraction method of painting style features based on convolutional neural network, International Journal of Arts and Technology, 14(1), 2022, 40-55. https://doi.org/10.1504/IJART.2022.122448
[6] Jin, H.; Yang, J.: Using computer-aided design software in teaching environmental artistic design, Computer-Aided Design and Applications, 19(S1), 2021, 173-183. https://doi.org/10.14733/cadaps.2022.S1.173-183
[7] Kimani, M.; Tesha, J.-M.; Twebaze, C.-B.: Investigation on the poor computer graphic design skills among art and design students at university, International Journal Social Sciences and Education, 6(10), 2019, 61-71. https://doi.org/10.20431/2349-0381.0610007
[8] Liu, F.; Yang, K.: Exploration on the teaching mode of contemporary art computer-aided design centered on creativity, Computer-Aided Design and Applications, 19(S1), 2021, 105-116. https://doi.org/10.14733/cadaps.2022.S1.105-116
[9] Liu, X.; Li, N.; Xia, Y.: Affective image classification by jointly using interpretable art features and semantic annotations, Journal of Visual Communication & Image Representation, 58(1), 2019, 576-588. https://doi.org/10.1016/j.jvcir.2018.12.032
[10] Milani, F.; Fraternali, P.: A dataset and a convolutional model for iconography classification in paintings, Journal on Computing and Cultural Heritage (JOCCH), 14(4), 2021, 1-18. https://doi.org/10.1145/3458885
[11] Munsch, A.: Millennial and Generation Z digital marketing communication and advertising effectiveness: A qualitative exploration, Journal of Global Scholars of Marketing Science, 31(1), 2021, 10-29. https://doi.org/10.1080/21639159.2020.1808812
[12] Pinciroli, V.-N.-O.; Milani, F.; Fraternali, P.; da Silva, T.-R.: Comparing cam algorithms for the identification of salient image features in iconography artwork analysis, Journal of Imaging, 7(7), 2021, 106. https://doi.org/10.3390/jimaging7070106
[13] Sharma, R.; Kaushik, B.; Gondhi, N.-K.; Tahir, M.; Rahmani, M.-K.-I.: Quantum particle swarm optimization based convolutional neural network for handwritten script recognition, Comput., Mater. Continua, 71(3), 2022, 5855-5873. https://doi.org/10.32604/cmc.2022.024232
[14] Singh, V.; Nanavati, B.; Kar, A.-K.; Gupta, A.: How to maximize clicks for display advertisement in digital marketing? A reinforcement learning approach, Information Systems Frontiers, 25(4), 2023, 1621-1638. https://doi.org/10.1007/s10796-022-10314-0
[15] Xu, C.; Huang, Y.; Dewancker, B.: Art inheritance: an education course on traditional pattern morphological generation in architecture design based on digital sculpturism, Sustainability, 12(9), 2020, 3752. https://doi.org/10.3390/su12093752
[16] Zhong, M.: Application of interaction design in new media advertising, International Journal of Frontiers in Sociology, 4(6), 2022, 27-33, https://doi.org/10.25236/IJFS.2022.040607