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Computer-Aided Design AND APPLICATIONS

# Intelligent Assessment of Advertising Art Design Based on Reinforcement Learning and Computer Vision

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**Abstract.** As consumers' aesthetic and taste preferences for advertising art design continue to evolve, traditional advertising design methods struggle to cater to the market's diverse demands. This study aims to bridge this gap by integrating the strengths of RL, computer vision technology, and CAD to develop a novel intelligent advertising art design assessment system. The findings reveal that the RL-based algorithm significantly outperforms the traditional back propagation neural network (BPNN) algorithm in terms of prediction accuracy, exhibiting a substantial improvement while narrowing the error margin. Furthermore, the proposed algorithm showcases superior operational efficiency, offering a swift solution for handling intricate advertising design assessment tasks. The RL-based algorithm shows better performance than the traditional BPNN algorithm in the field of advertising design assessment, which not only provides advertisers and designers with more accurate and efficient assessment tools but also helps to optimize advertising design strategies. This research achievement has important practical significance for promoting the deep integration of the advertising design field and CAD and for the intelligent upgrade of the advertising industry.

**Keywords:** Strengthen Learning; Computer Vision; Advertising Art Design; Intelligent Assessment
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## 1 INTRODUCTION

In today's era of information overload, advertising art design plays a pivotal role in conveying brand values, grabbing consumer attention, and boosting sales. Its significance has grown exponentially. With the rapid development of computer technology, computer graphics processing has become an indispensable part of visual communication advertising design. Computer graphics processing provides advertising designers with a vast creative space through its powerful image processing capabilities and creative tools, making advertising works more vivid and attractive. Fan and Li [1] discussed the application and impact of computer graphics processing in visual communication advertising design. Computer graphics processing provides advertising designers with rich image processing tools. Traditional advertising design often relies on hand drawing or photography to create images, but these methods are often limited by time, cost, and technology. Computer graphics processing software such as Adobe Photoshop, Illustrator, etc. provides rich image processing functions such as filters, colour adjustment, synthesis, etc., making it easy for advertising designers to process images and achieve better visual effects. Amidst fierce market competition, the creativity and quality of advertising art designs directly impact brand imaging and market standing. However, traditional assessment methods, often relying on subjective assessments or simplistic quantitative metrics, struggle to objectively capture the true worth and market potential of designs. In advertising art design, the application of Photoshop and Illustrator is becoming increasingly widespread. They each have unique charm and advantages, especially in university visual communication design, their application is indispensable. Guan and Ko [2] discussed the application of Photoshop and Illustrator in advertising art design, using university visual communication design as an example. As a powerful image processing software, Photoshop plays an important role in advertising art design. In university visual communication design, Photoshop is often used to modify, tone, and synthesize images, thereby enhancing the visual effect of advertising works. For example, in poster design, designers can use Photoshop to beautify photos and make them more eye-catching. In advertising brochure design, designers can cleverly blend different images and elements together through Photoshop to form a unified visual style.

Hence, the quest for a more nuanced and efficient assessment approach has become a focal point for both industry insiders and academic researchers. The rapid advancements in artificial intelligence, particularly in reinforcement learning (RL) and computer vision, have opened up new avenues for intelligent advertising art design assessment. RL, a key machine learning paradigm, has achieved notable successes in various domains by learning optimal decision-making strategies through agent-environment interactions. With the rapid development of technology, artificial intelligence technology has penetrated every aspect of our lives, among which its application in computer-aided art visual advertising art is particularly remarkable. The introduction of artificial intelligence technology not only brings new innovations to advertising art but also provides designers with more efficient and accurate visual design tools. Firstly, artificial intelligence technology can provide automation and intelligence support in advertising design. In the process of art visual design, it is usually necessary to handle a large amount of images, graphics, and video materials, which are both tedious and time-consuming. The application of artificial intelligence technology can automate these tasks, greatly improving design efficiency. For example, artificial intelligence can automatically classify, recognize, and optimize images through deep learning techniques, providing designers with high-quality materials [3]. Meanwhile, computer vision technology excels at extracting valuable insights from vast image datasets, enabling automatic comprehension and analysis of visual content. The convergence of these two technologies promises transformative changes in advertising art design assessment.

This study aims to forge a novel intelligent assessment framework for advertising art designs, leveraging the powers of RL and computer vision. By utilizing RL models to refine design decisions and computer vision techniques to automatically identify and quantitatively assess design outcomes, we strive for a comprehensive, unbiased, and efficient assessment process. With the rapid development of computer technology, the application of computer-aided design software (CAD) in art environment art design is becoming increasingly widespread. This software provides designers with powerful tools to help them create, optimize, and present design solutions more efficiently. Jin and Yang [4] discussed the application of computer-aided design software in art environment art design and the advantages it brings. Computer-aided design software provides precise and efficient drawing tools for environmental art design. Traditional manual drawing methods are often time-consuming and prone to errors, while CAD software can help designers quickly generate high-quality design drawings through precise measurements and calculations. In addition, this software also provides rich drawing tools and material libraries, allowing designers to easily create various complex design schemes. Through software-generated 3D models and rendering effects, designers can also present design solutions more intuitively to clients and stakeholders, improving communication efficiency. With the rapid development of the advertising industry and the increasing diversification of consumer aesthetics, advertising art design is facing unprecedented challenges and opportunities. In this context, computer vision design, as an emerging design tool, provides diverse forms and innovative perspectives for advertising art design. Liu et al. [5] analyzed computer-aided design in diverse forms of art and design. Whether it is image recognition and analysis, construction and rendering of 3D models, or simulation and preview of dynamic effects, computer vision design can provide strong technical support for advertising art design. This enables designers to use various design elements more flexibly and efficiently, creating a rich and diverse range of advertising works. The application of computer vision design in advertising art design has promoted the diversification and innovation of advertising forms. Traditional advertising forms are often limited to flat posters, television advertisements, etc., while computer vision design can combine advertising elements with new technologies such as virtual reality and augmented reality to create an immersive advertising experience. This novel advertising form not only attracts consumer attention, improves advertising exposure and conversion rates, but also shapes a unique image and style for the brand. This approach not only elevates the quality and market competitiveness of advertising art designs but also underpins the innovative growth of the advertising design industry. The proposed methodology offers a more scientific and streamlined assessment process for the advertising design sector, aiding in the enhancement of design quality and market appeal. Moreover, its applications extend to advertising design education, design competitions, and beyond, bolstering the training of exceptional designers and the selection of outstanding designs.

With the continuous advancement of technology and the increasing maturity of computer-aided design (CAD) tools, the application of contemporary art in advertising design is becoming increasingly widespread. Especially in creative advertising design, computer-aided design tools not only improve design efficiency but also provide unlimited possibilities for the realization of creativity. Liu and Yang [6] explored the application of contemporary art computer-aided design in creative advertising. Computer-aided design tools provide powerful technical support for the application of contemporary art in advertising design. Designers can use these tools to integrate various artistic styles and elements into advertising design, creating unique and creative advertising works. Whether it is the application of abstract art, the deconstruction of cubism, or the imagination of surrealism, computer-aided design tools can help designers accurately achieve these creative ideas. Designers need to maintain an accurate grasp of the advertising purpose and brand image while pursuing creativity, ensuring that the overall effect of advertising design meets brand demands and market positioning. Lo and Cheng [7] explored the mediating role of virtual reality visual tourism advertising and how it affects consumer responses. Virtual reality technology has created a highly realistic and immersive environment for tourism advertising. Through VR devices, consumers can experience the beauty, atmosphere, and culture of tourist destinations as if they were there, far surpassing traditional image and text advertisements. This immersive experience generates a stronger interest and curiosity among consumers toward tourism destinations, thereby stimulating their willingness to travel and purchase behaviour. Virtual reality visual tourism advertisements can also influence consumer decision-making processes by providing rich information and interactive experiences. Consumers can gain a detailed understanding of the facilities, services, prices, and other information of tourist destinations through VR advertising, and even simulate and experience different tourism routes and activities. This comprehensive and in-depth information display and interactive experience enable consumers to make wiser and more satisfactory travel decisions. The study's novelty lies in the integration of RL and computer vision in advertising art design assessment. This integration not only surpasses the limitations of traditional assessment methods, enhancing accuracy and efficiency but also contributes fresh perspectives and directions to the advertising design industry's innovative trajectory. Furthermore, this research serves as a valuable reference for scholars in adjacent fields, catalyzing the broader application and deeper development of AI technologies in advertising design.

Specifically, this study delves into several key aspects. Firstly, it systematically collates and critiques the current research landscape and challenges in advertising art design assessment methods. Secondly, it delves into the application and feasibility of RL within the realm of computer vision. Thirdly, it crafts an RL model tailored for intelligent advertising art design assessment, designing appropriate state spaces, action spaces, and reward functions. Finally, it validates the proposed methodology's efficacy through rigorous experimentation, paving the way for its practical deployment in advertising art design assessment.

## 2 LITERATURE REVIEW

With the rapid development of computer new media technology, the advertising industry is undergoing unprecedented changes. Especially interactive visual advertising, due to its unique interactivity and attractiveness, has become an important means of brand promotion and marketing. In this context, Meng and Huang [8] analyzed that reinforcement learning-based techniques provide a new perspective and method for interactive visual advertising design. In interactive visual advertising design, reinforcement learning can be used to simulate and optimize the interaction process between users and advertisements. Designers can set a series of reward and punishment mechanisms to automatically adjust and optimize the performance of advertisements in the process of interacting with users. In this way, advertising can not only better attract user attention, but also make real-time adjustments based on user feedback and behavioural habits, improving the effectiveness and conversion rate of advertising. The computer new media environment provides rich forms of expression and interactive means for interactive visual advertising. Through interactive devices such as touch screens and sensors, advertisements can capture user actions and postures, achieving more natural and intuitive interaction. These new technologies and media environments not only enhance the fun and appeal of advertising but also provide designers with more creative space.

With the advancement of technology, virtual reality (VR) technology has gradually penetrated various fields, including the art field. As an important venue for art display and dissemination, art museums have also begun to attempt to combine virtual reality technology with art advertising to create a brand-new exhibition experience. Parker and Saker [9] explored the integration of art museum advertising and virtual reality and examined the impact of virtual reality technology on space. The integration of art museum advertising and virtual reality provides viewers with an immersive exhibition experience. Traditional art museum advertisements often only showcase artworks and the characteristics of the museum through pictures and text, making it difficult to fully convey the charm of artworks and the atmosphere of the museum. Virtual reality technology can create highly realistic virtual environments, allowing viewers to feel as if they are inside an art museum, experiencing the details of artworks and the spatial layout of the museum firsthand. This immersive experience allows the audience to have a deeper understanding of the charm of artworks and art museums, thereby increasing their interest and curiosity in art museums. The advertising industry, as an important field of information dissemination and commercial promotion, has also undergone profound changes in this wave. Especially with the introduction of machine vision and machine learning technologies, a new solution has been provided for advertising recognition and classification. Machine vision is a technology that simulates the human visual system, capturing image information through cameras, sensors, and other devices and using algorithms to process, analyze, and understand images. In the field of advertising, machine vision technology can be widely applied to the detection of billboards, recognition of advertising content, and evaluation of advertising effectiveness. Machine vision can automatically detect and locate the position of various billboards scattered throughout the city through image recognition technology and then extract and recognize the advertising content. This not only greatly improves the efficiency of advertising monitoring but also provides advertisers with a more accurate and objective analysis of advertising effectiveness. In advertising recognition and classification, machine learning techniques can automatically learn the features and patterns of advertisements based on a large amount of advertising data, thereby achieving automatic classification and recognition of advertisements [10].

In the process of advertising design and production, details determine success or failure. Any small flaw or flaw can affect the overall effectiveness of the advertisement and even damage the brand image. With the continuous development and improvement of machine vision technology, its application in defect detection is becoming more and more widespread, providing strong technical support for defect compensation in advertising design. Ren et al. [11] analyzed the defect detection technology based on machine vision for monitoring defects in advertising design. Machine vision technology is a technique that perceives, analyzes, and understands image information by simulating the human visual system. In advertising design, machine vision technology can be applied to multiple aspects such as quality inspection of advertising materials and defect detection of advertising products. For example, in the production process of advertising printed materials, machine vision systems can collect and analyze images of printed materials. Automatically detect defects such as ink dots, scratches, and colour deviations on printed materials, thereby promptly identifying and repairing problems. With the rapid development of information technology and the widespread application of cloud computing technology, computer-aided art design evaluation of advertising promotion systems has become a hot research field. The introduction of cloud computing technology provides powerful computing and data storage capabilities for the art and design evaluation of advertising promotion systems, enabling designers to more efficiently evaluate and optimize design proposals. Shi and Sun [12] use cloud computing technology to provide massive data storage and processing capabilities for the artistic design of advertising promotion systems. In advertising promotion systems, designers usually need to handle a large amount of design materials and data, and the storage and processing of these data is a huge challenge for designers. Cloud computing technology can help designers easily cope with this challenge through its powerful data storage and processing capabilities. Designers can store design materials and data in the cloud for anytime, anywhere access and processing, greatly improving design efficiency and convenience.

With the rise of new media, the integration between visual communication technology and advertising art has become increasingly close. In this context, computer-aided interactive technology has become an important bridge connecting the two. Wang [13] explored the computer-aided interaction between visual communication technology and advertising art in the context of new media and analyzed its impact on the advertising industry. Firstly, new media scenes provide a broad stage for visual communication technology and advertising art. New media platforms such as social media, short videos, and augmented reality (AR) offer unlimited possibilities for advertising creativity. On these platforms, visual communication technology quickly and accurately conveys advertising information to target audiences through various forms such as text, images, and videos. Meanwhile, advertising art makes advertising content more attractive and infectious through creativity and aesthetics. With the rapid development of cloud computing and Internet of Things technology, they have begun to penetrate various fields of artistic creation, bringing unprecedented creative inspiration and tools to artists. Graffiti art, as a beloved art form among young people, has also begun to combine with these advanced technologies, presenting a new visual expression and artistic style. Reinforcement learning, as an important machine learning technique, has achieved significant results in multiple fields. In the field of advertising design, computer-assisted advertising design based on reinforcement learning has also shown great potential. Yang and Liu [14] explored computer-aided advertising design based on reinforcement learning for visual communication expression. Firstly, reinforcement learning is a technique that achieves optimal decision-making through trial-and-error learning. In advertising design, reinforcement learning-based auxiliary design systems can find the most attractive visual communication method to the target audience by constantly trying and adjusting design elements. This technology can help designers quickly find the best design solution in massive amounts of data, improving design efficiency and quality. Secondly, a computer-aided advertising design system based on reinforcement learning can automatically optimize visual elements in advertisements. The system can automatically adjust elements such as images, text, and colours in advertisements based on feedback and behavioural data from the target audience, making the advertisements more in line with the preferences and needs of the audience. This automated optimization process can greatly reduce the workload of designers and improve the efficiency and effectiveness of advertising design. With the advancement of technology and the widespread application of artificial intelligence technology, Intelligent Computer-Aided Design (ICAD) has become an important tool in the field of packaging design. Especially in the appearance design of packaging advertising art style, ICAD not only improves design efficiency but also brings designers more creative possibilities and exploration of artistic style. Zhao et al. [15] analyzed the appearance design of agricultural product packaging art style with the assistance of intelligent computers. Firstly, intelligent computer-aided design, through machine learning and big data analysis, can help designers quickly capture and understand the aesthetic trends and consumer preferences of the target market. This means that designers can more accurately position the style and tone of advertising packaging design to meet the needs of different consumer groups. For example, by analyzing popular colours, patterns, and layout styles in recent years, designers can create packaging advertising works that are more in line with market trends.

## 3 RESEARCH METHOD

As a pivotal aspect of the advertising design process, the assessment of advertising art design has consistently garnered significant attention within advertising and design communities. The evolution of technology has progressively shifted assessment methods from subjective assessments towards more objective and quantitative data-driven approaches. Notably, the emergence of artificial intelligence techniques, including machine learning and deep learning, has introduced innovative perspectives and methodologies for assessing advertising art design.

Regarding traditional assessment methods, scholars typically rely on questionnaires, expert reviews, and similar means. Nevertheless, these approaches are constrained by sample size and subjectivity, challenging the objectivity and comprehensiveness of the assessment outcomes. To address these limitations, some researchers have explored the application of machine learning in advertising art design assessment. For instance, This method enables automatic recognition of advertisement design styles through feature extraction and classification of visual components. While this approach enhances objectivity, it remains constrained by the precision of feature extraction and classifier performance. Their neural network model, comprising multiple convolution layers, facilitates automatic feature extraction and scoring of advertisement design images.

Reinforcement Learning (RL), a significant machine learning paradigm, learns optimal decision-making strategies through agent-environment interactions. In recent years, RL's application in computer vision has made notable advancements. For instance, RL has demonstrated effectiveness in tasks like object detection and image segmentation. To sum up, the research in the field of advertising art design assessment presents a diversified development trend. Although the traditional assessment method is simple and easy, it is limited by subjectivity and sample size. The assessment method based on machine learning and computer vision technology has improved the objectivity and accuracy of assessment to some extent, but it still faces challenges such as feature extraction and classifier performance. The application of emerging technologies such as RL brings new possibilities and opportunities for the assessment of advertising art design. The purpose of this study is to realize the intelligent assessment of advertising art design through RL and computer vision technology. In order to achieve this goal, we design a unique assessment framework that combines the decision-making ability of the RL model with the feature extraction ability of computer vision technology. The following section will introduce the construction process of this assessment framework in detail, including the construction of the RL model, the application of computer vision technology, and the combination of the two.

### 3.1 RL Model Construction

RL is a machine learning method that learns the optimal decision strategy through interaction between agents and the environment. In the intelligent assessment of advertising art design, we model the assessment process as a Markov decision process, in which the state space represents different feature combinations of advertising art design, the action space represents different grades of assessment results, and the reward function is set according to the accuracy of assessment results. In the intelligent assessment of advertising art design, the image features and text features of advertising art design are input into the deep neural network.

Using training data designated $x_i, y_i \; {}_{i=1}^{l}$ for advertising art design assessment, $x_i \in R^n$ serving as the input for $i$ design parameters and $y_i \in R^n$ representing the output of $i$ design parameters, we can derive the following:

$$f \;\; x \;\; = \omega^T \cdot \phi \;\; x \;\; + b \tag{1}$$

$\phi \;\; x$ is a nonlinear mapping function responsible for converting data from a lower to a higher dimension, while $\omega$ signifies the weight vector. Unlike traditional BPNN, which relies on empirical risk minimization, the Least Squares Support Vector Machine (LS-SVM) adopts the structural risk minimization principle. Consequently, the optimization objective function for the mentioned formula can be obtained as indicated below:

$$\min_{\omega,b,\xi} J \;\; \omega,\xi \;\; = \frac{1}{2}\omega^T\omega + \frac{\gamma}{2}\sum_{i=1}^{n}\xi_i^2 \tag{2}$$

In this context, $\xi_i$ signifies the regression error associated with the least squares support vector machine while $\gamma$ serving as the regularization parameter that has an impact on both the regression error and generalization performance.

In this study, RL is applied to the intelligent assessment of advertising art design. Through the interactive learning between agents and the environment, effective assessment criteria can be automatically found, and the data support and sample generation function provided by computer-aided design (CAD) can improve the accuracy of assessment. RL model uses accurate data obtained by CAD to learn the characteristics and assessment strategies of advertising art design, while a large number of samples generated by CAD are used for model training. Finally, through the visual display function of CAD, we intuitively verified the effectiveness of the RL model in the assessment of advertising art design. This method of combining RL and CAD technology promotes intelligent development in the field of advertising art design. The structure of the RL model in this article is shown in Figure 1.

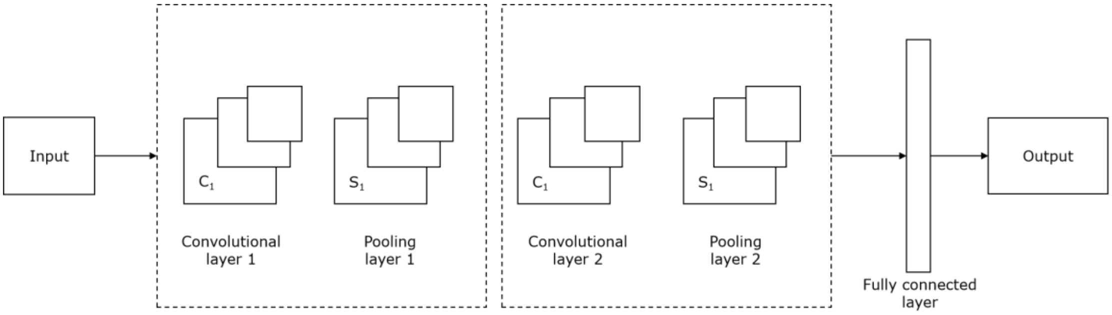


**Figure 1**: RL model structure.

In order to improve the assessment accuracy of the model, experience playback and target network are used. Experience playback stores the interactive experience of agents in an experienced pool and randomly selects samples from it for training, thus breaking the correlation between samples and improving the stability of the model.

## 3.2 Application of Computer Vision Technology

Computer vision technology is a method to extract useful information from image or video data. In the intelligent assessment of advertising art design, we use computer vision technology to extract features and quantitatively evaluate the images of advertising art design. In this study, CNN is used as a feature extractor, and the images of advertising art design are input into CNN. The low-level features and high-level features of the images are extracted through the convolution layer and pooling layer of the network, and then these features are input into the fully connected layer for classification or regression.

The process of identification and design assessment of advertising artistic features is a comprehensive analysis process that combines computer vision and RL technology. Firstly, the characteristics of advertising images are extracted by computer vision technology to identify their unique artistic elements and visual styles; Then, the RL model is used to deeply analyze these characteristics, and the assessment strategy is automatically learned and optimized according to the preset assessment criteria. Finally, combined with multi-dimensional data such as text information and user feedback on advertising design, the artistry and effectiveness of advertising design are comprehensively and objectively evaluated quantitatively. The process of advertising artistic feature identification and design assessment is shown in Figure 2.

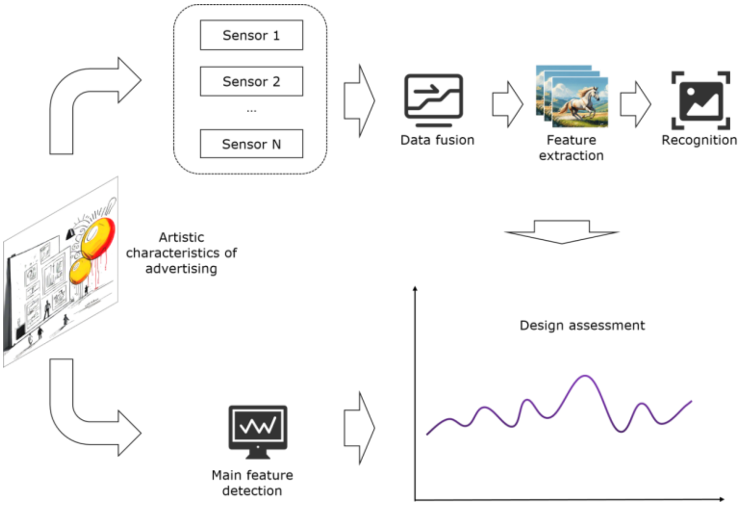


**Figure 2**: Identification and design assessment of advertising artistic features.

Enhancing BPNN through adaptive learning rate adjustment:

$$\Delta X = lr \cdot \frac{\partial E}{\partial X} \tag{3}$$

$$\Delta X(k+1) = mc \cdot \Delta X(k) + lr \cdot mc \cdot \frac{\partial E}{\partial X} \tag{4}$$

In this scenario, $lr$ represents the learning rate, which $mc$ stands for the momentum factor. The inclusion of the momentum term effectively functions as a damping term, mitigating oscillatory tendencies during the learning process. This, in turn, enhances convergence and facilitates the discovery of a superior solution.

It $x_i(t)$ is the input data at time $t$ and $o_j(t)$ is the output data generated at time $t$ during time $j$, then the neuron $j$'s state can be represented as:

$$o_j(t) = f\left\{\left[\sum_{i=1}^{n} \omega_{ij} x_i(t - \tau_{ij})\right] - T_j\right\} \tag{5}$$

In this context, $\tau_{ij}$ refers to the synaptic delay, $T_j$ represents the threshold of neurons, $i$ $j$ signifies the weight of $\omega_{ij}$ neurons, and $f\ \cdot$ denotes the transfer function.

If $\tau_{ij}$ represents a unit of time, then the following applies:

$$o_j\ t+1\ = f\left\{\left[\sum_{i=1}^{n}\omega_{ij}x_i\ t\ \right]-T_j\right\} \tag{6}$$

The subscripts for input and output signify the varied modes of neuron model input and output, enabling us to leverage this model attribute for addressing distinct challenges based on specific requirements. The formula below represents the neuron input at the time $t$:

$$net_j^{'}\ t\ = \sum_{i=1}^{n}\omega_{ij}x_i\ t \tag{7}$$

Regarding the aforementioned formula, neurons are only functional when $net_j^{'}\ t\ > T_j$. Upon simplification, the neuron model can be transformed as follows:

$$o_j = f\ net_j\ \ = f\ W_j^T X \tag{8}$$

In this study, the training process of the model is to learn effective assessment strategies by constantly letting agents interact with advertising art design works. Specifically, we use CAD technology to obtain accurate data on advertising art design and input it into the RL model as a state. The model selects the assessment action according to the current state and obtains the corresponding reward signal; Through continuous iterative optimization, the model gradually learns the strategy of accurately evaluating the quality of advertising art design according to its characteristics, thus realizing the intelligent assessment of advertising art design. The formula for adjusting weights with the inclusion of a momentum factor:

$$\Delta W\ t\ = \eta\delta X + \alpha\Delta W\ t-1 \tag{9}$$

In this formula, $W$ represents the weight matrix, $X$ denotes the input vector, and $\alpha$ stands for the momentum coefficient, typically set as $\alpha \in\ 0{,}1$ .

The rate of learning is determined as follows:

$$\Delta w = -\eta\frac{\partial E}{\partial w} \tag{10}$$

If the learning rate is excessively high, it can enhance the convergence speed. However, a lower learning rate ensures stable convergence during training but at a slower learning pace.

After extracting the image features of advertising art design, it is necessary to combine these features with the RL model. Therefore, we design a feature fusion module, which fuses image features with other types of features (such as text features, user behaviour features, etc.) to obtain a unified feature representation vector. Then, this feature vector is input into the RL model as the state input, thus realizing the combination of computer vision technology and the RL model.

## 3.3 Combination of RL and Computer Vision

In the field of intelligent assessment of advertising art design, the close combination of RL model and computer vision technology shows great potential. This combination not only improves the automation level of assessment but also significantly improves the accuracy and efficiency of assessment results.

Computer vision technology plays a key role here. Image elements in advertising art design often bear rich visual information and artistic expression and are an indispensable part of assessment. Through computer vision technology, we can automatically extract low-level features and high-level features from the images of advertising art design. Low-level features, such as colour, texture and shape, are the basic elements of an image; Advanced features, such as object recognition and scene understanding, provide a deeper interpretation of image content. The comprehensive utilization of these features has laid a solid foundation for subsequent quantitative assessment and decision-making learning.

However, it is not enough to rely solely on image features. The advertising art design is a multi-dimensional complex system, which also contains many types of characteristics such as text, user behaviour, market trends and so on. Therefore, after extracting image features, we need to fuse these features with other related features to form a comprehensive and unified feature representation vector. This process involves many steps, such as feature selection, feature transformation and feature fusion, in order to ensure that features from different sources can be properly expressed and weighed in the same vector space.

This unified feature representation vector is input into the RL model as the state input. RL model gradually mastered an effective assessment strategy through continuous interactive learning with the environment. In this process, the model will predict the potential benefits of different assessment results according to the input state vector, and make decisions according to these prediction results. Through continuous iteration and optimization, the RL model can gradually discover those feature combinations and assessment criteria that really affect the assessment of advertising art design, thus achieving a more accurate and efficient intelligent assessment.

## 4 RESULT ANALYSIS AND DISCUSSION

This article devises an array of experiments to substantiate the efficacy and merits of the introduced advertising design assessment approach grounded in the RL algorithm. Utilizing datasets encompassing diverse advertising design attributes, we conducted a comparative analysis between the RL algorithm and the conventional BPNN method in terms of model training, performance assessment, and execution time. The conclusive findings reveal that the RL algorithm exhibits notable superiority in precision, efficiency, and handling of intricate data, thereby offering a novel and potent tool for advertising design assessment.

When juxtaposing the predictive capabilities of the traditional BPNNalgorithm against the RL algorithm, marked disparities emerge from the scatter plots depicted in Figures 3 and 4. Figure 3 portrays the distribution of predicted versus actual values for the BPNN algorithm, whereas Figure 4 illustrates the analogous outcomes for the RL algorithm. Notably, the RL algorithm has considerably enhanced prediction accuracy in comparison to the BPNN algorithm. In Figure 4, the predicted and actual values for the RL algorithm are more tightly clustered along the diagonal, signifying minimal divergence between the predicted and actual values. Conversely, the scatter plot for the BPNN algorithm in Figure 3 exhibits a relatively more scattered distribution, indicating a substantial discrepancy between the predicted and actual results.

RL algorithm shows stronger adaptability when dealing with complex data. It can adjust its prediction strategy through interactive learning with the environment, so as to better capture the nonlinear relationship and dynamic changes in the data. Although the BPNN algorithm is also a powerful machine learning algorithm, its fixed network structure and parameters may limit its adaptability to data when dealing with some complex problems, resulting in worse prediction performance than the RL algorithm. RL algorithm finds a more robust and generalized prediction model through trial and error learning. In contrast, the BPNN algorithm may perform well on training data, but its generalization ability may be limited when facing new data, which leads to a decline in prediction performance.

The comparison of the error of the advertising design assessment algorithm before and after improvement shown in Figure 5 provides us with direct evidence of the improvement of the algorithm performance. Compared with the original BPNN algorithm, the improved design assessment algorithm in this article has greatly reduced the error index.

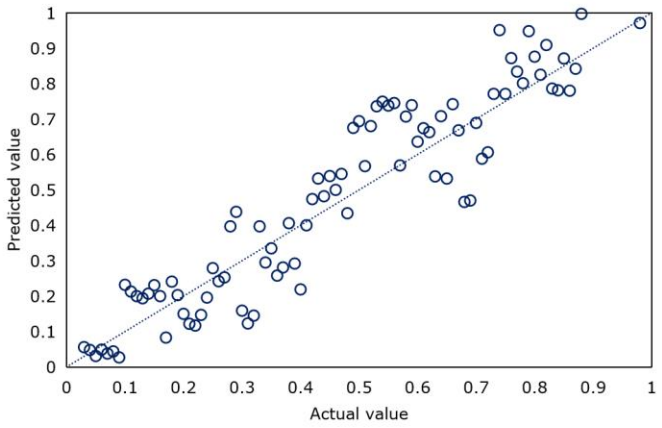


**Figure 3**: Prediction effect of traditional BPNN.

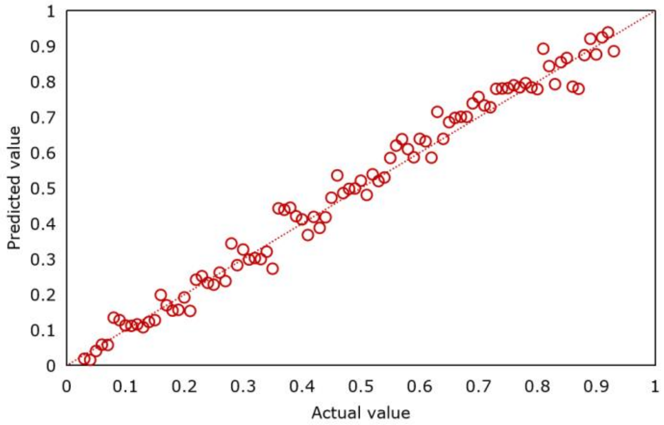


**Figure 4**: Prediction effect of RL algorithm.

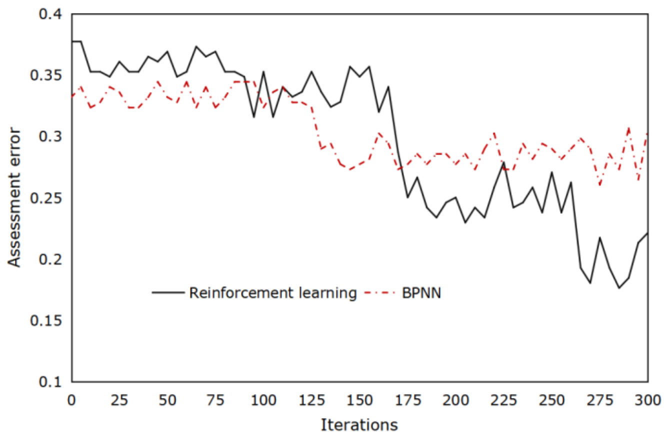


**Figure 5**: Comparison of errors before and after improvement of the algorithm.

In contrast to the enhanced BPNN algorithm, the refined approach introduced in this study demonstrates considerably lower error rates in predicting advertising design impact. This enhanced precision enables a more accurate assessment of the actual effectiveness of advertising designs, thereby offering advertisers and designers a more dependable decision-making tool. The substantial error reduction directly attests to the efficacy of the proposed algorithm. By introducing new technology or optimizing the structure and parameters of existing algorithms, the improved algorithm can better capture the key elements in advertising design and make a more accurate quantitative assessment. The reduction of error reflects the improvement of data fitting and generalization ability of the improved algorithm. This means that the algorithm can not only better adapt to the training data, but also maintain good prediction performance on the unknown data. This is very important for the assessment of advertising design in practical application because the algorithm needs to be able to deal with various types of advertising design.

Figure 6 presents a comparison of advertising design assessment accuracy achieved by various algorithms. Evidently, when pitted against the conventional BPNN algorithm, the RL algorithm-based approach demonstrates marked improvement in the accuracy of advertising design assessment.

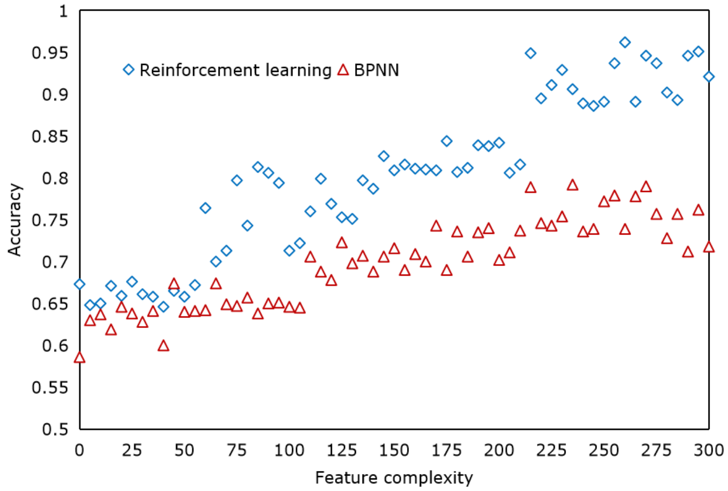


**Figure 6**: Assessment accuracy of the algorithm.

The data in Figure 6 clearly shows that the accuracy of the RL algorithm is significantly improved compared with the traditional BPNN algorithm. This means that the RL algorithm performs better in identifying key elements in advertising design and predicting its actual effect.

RL algorithm optimizes decision-making strategy through interactive learning between agent and environment, which makes it more adaptable and flexible in dealing with complex and dynamic advertising design assessment problems. In contrast, the traditional BPNN algorithm may be limited by the fixed network structure and parameter settings, and it is difficult to fully capture the changeable factors in advertising design. RL algorithm can automatically learn the effective features in advertising design, and optimize the assessment strategy according to these features. This close combination of feature learning and strategy optimization enables the algorithm to maintain a high assessment accuracy in the ever-changing data environment.

The algorithm runtime comparison depicted in Figure 7 offers a straightforward visualization of the efficiency disparities among various algorithms when tackling advertising design assessment tasks. Notably, the algorithm introduced in this study exhibits clear superiority in terms of runtime when compared to the benchmark algorithm.

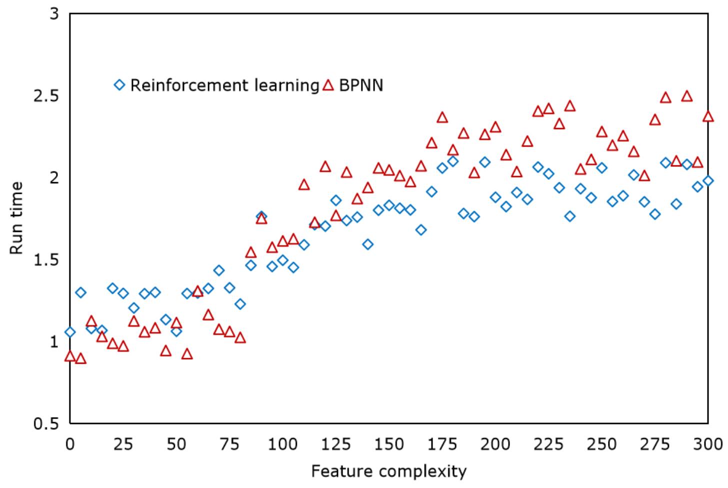


**Figure 7**: Algorithm running time.

In Figure 7, the running time of our algorithm is obviously shorter than that of the contrast algorithm, which shows that our algorithm can give results faster when dealing with the same task. This time advantage is particularly important in practical applications because it means a faster decision-making cycle and higher work efficiency. The algorithm in this article may be optimized in the complexity of the algorithm, which reduces the amount of calculation needed to deal with the task of advertising design assessment. This optimization may include more efficient use of data structures, simpler algorithm logic or more efficient calculation methods.

## 5 CONCLUSIONS

The advent of cutting-edge artificial intelligence technology, particularly advancements in RL and computer vision, has ushered in novel opportunities for intelligent assessment of advertising art design. This study endeavours to forge a fresh intelligent assessment approach for advertising art design, leveraging the potential of RL and computer vision technology.

In predictive accuracy, the RL algorithm has exhibited remarkable superiority over the BPNN algorithm. Whether through the comparative analysis of scatter plots juxtaposing predicted and actual values or the examination of error scenarios, the RL algorithm consistently demonstrates superior predictive accuracy and a narrower error margin. This underscores the RL algorithm's proficiency in capturing intricate relationships and dynamic shifts in advertising design.

Furthermore, in terms of execution speed, the proposed algorithm in this study showcases substantial efficiency gains. These advantages might stem from various factors, including algorithmic optimization, more effective utilization of computational resources, or the incorporation of parallel processing techniques. In practical terms, this translates into faster assessment results for advertisers and designers, subsequently accelerating decision-making and enhancing overall workflow efficiency.

In conclusion, the findings of this study highlight the outstanding performance of the RL-based advertising design assessment algorithm in both predictive accuracy and operational efficiency. This contributes novel insights and methodologies to the assessment landscape in advertising design. Looking ahead, we are committed to exploring further optimizations in algorithm performance, aiming to deliver even more streamlined advertising design assessments across a broader spectrum of scenarios.

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REFERENCES

[1] Fan, M.; Li, Y.: The application of computer graphics processing in visual communication design, Journal of Intelligent & Fuzzy Systems, 39(4), 2020, 5183-5191. https://doi.org/10.3233/JIFS-189003

[2] Guan, C.-L.; Ko, C.-H.: Photoshop and illustrator use in instructional design: a case study of college visual communication course design, The International Journal of Design Education, 15(1), 2021, 119. https://doi.org/10.18848/2325-128X/CGP/v15i01/119-1303

[3] He, C.; Sun, B.: Application of artificial intelligence technology in computer aided art teaching, Computer-Aided Design and Applications, 19(S4), 2021, 118-129. https://doi.org/10.14733/cadaps.2021.S4.118-129

[4] Jin, H.; Yang, J.: Using computer-aided design software in teaching environmental art design, Computer-Aided Design and Applications, 19(S1), 2021, 173-183. https://doi.org/10.14733/cadaps.2022.S1.173-183

[5] Liu, F.; Gao, Y.; Yu, Y.: Computer aided design in the diversified forms of artistic design, Computer-Aided Design and Applications, 19(S3), 2021, 33-44. https://doi.org/10.14733/cadaps.2022.S3.33-44

[6] 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

[7] Lo, W.-H.; Cheng, K.-L.-B.: Does virtual reality attract visitors? The mediating effect of presence on consumer response in virtual reality tourism advertising, Information Technology & Tourism, 22(4), 2020, 537-562. https://doi.org/10.1007/s40558-020-00190-2

[8] Meng, W.; Huang, L.: Study on design of interactive advertising in the environment of new media, Arts Studies and Criticism, 3(1), 2022, 93-97. https://doi.org/10.32629/asc.v3i1.711

[9] Parker, E.; Saker, M.: Art museums and the incorporation of virtual reality: Examining the impact of VR on spatial and social norms, Convergence, 26(5-6), 2020, 1159-1173. https://doi.org/10.1177/1354856519897251

[10] Penumuru, D.-P.; Muthuswamy, S.; Karumbu, P.: Identification and classification of materials using machine vision and machine learning in the context of industry 4.0, Journal of Intelligent Manufacturing, 31(5), 2020, 1229-1241. https://doi.org/10.1007/s10845-019-01508-6

[11] Ren, Z.; Fang, F.; Yan, N.; Wu, Y.: State of the art in defect detection based on machine vision, International Journal of Precision Engineering and Manufacturing-Green Technology, 9(2), 2022, 661-691. https://doi.org/10.1007/s40684-021-00343-6

[12] Shi, X.; Sun, Y.: Computer-aided cloud computing for advertising promotion system, Computer-Aided Design and Applications, 17(S1), 2019, 90-100. https://doi.org/10.14733/cadaps.2020.S1.90-100

[13] Wang, R.: Computer-aided interaction of visual communication technology and art in new media scenes, Computer-Aided Design and Applications, 19(S3), 2021, 75-84. https://doi.org/10.14733/cadaps.2022.S3.75-84

[14] Yang, K.-K.; Liu, F.-G.: Computer-aided design of visual communication expression with creativity as the core, Computer-Aided Design and Applications, 19(S3), 2022, 65-74. https://doi.org/10.14733/cadaps.2022.S3.65-74

[15] Zhao, Z; Zheng, H.; Liu, Y.: The appearance design of agricultural product packaging art style under the intelligent computer aid, Computer-Aided Design and Applications, 19(S3), 2021, 164-173. https://doi.org/10.14733/cadaps.2022.S3.164-173