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Research Article

Application of Modern Urban Landscape Design Based on Machine Learning Model to Generate Plant Landscaping

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With the continuous improvement of the living standards of people, the requirements of people for the environment in which they are located are gradually increasing, which makes urban landscape design work more and more important. Plant landscaping is the core component of urban landscape design. By analyzing and discussing the application of plant landscaping in urban landscape design, the quality level of urban landscape design can be further improved, thereby promoting the sustainable development of urban construction. Machine learning makes it possible to realize the intelligent processing of data and make full use of the knowledge and value contained in the data. This paper explores the way of intelligent analysis and application based on machine learning in the field of landscape architecture. First, the *k*-means machine learning clustering method is used to determine the types of plant landscaping required by modern urban landscape design. Experiments show that our model can be well applied to design applications of modern urban landscapes.

1. Introduction

Machine learning is a way to realize artificial intelligence and a key technology for processing big data. Machine learning algorithms can automatically analyze one or several types of data to obtain rules, discover the mechanism of action, and use the rules to predict unknown data. At present, it has become possible to apply machine learning (including deep learning) to the fields of landscape architecture, urban planning, and architecture to solve related problems such as human settlements. Scikit-learn, an open-source machine learning library based on Python language, integrates mainstream core algorithms in the field of machine learning, including classification, regression, and clustering algorithms, and data preprocessing methods; TensorFlow, an open-source deep-learning library based on Python language, uses computational graph, and automatic differentiation and customization are used for numerical calculations. Because of the emergence and rapid growth of machine learning open source libraries, and the gradual improvement of a large number of core algorithms, machine learning as a tool has been widely used in various fields, and landscape architecture is also in the exploratory stage.

Plants are an important element in the construction of garden landscapes. Today, with the continuous emphasis on the construction of ecological civilization, people are more yearning for green space, so garden plant landscaping has received more attention and attention, and its dominant position in landscape garden design has become more and more obvious. At this stage, designers often use horizontal and vertical section drawings to analyze and deliberate plans, but relying only on artificial design limits the possibility of landscape design. Therefore, designers and industry-related personnel urgently need new technology to assist them to better complete the landscaping design of garden plants. With the development of science and technology, the application of machine learning to garden plant landscaping has become a breakthrough to solve the problem.

There are many classic machine learning algorithms that have application potential in landscape architecture design. According to the focus of solving the problem, it can be divided into algorithms with efficient data classification capabilities, such as naive Bayesian algorithm, support vector machine decision tree, regression tree, and random forest [1], which are mostly used for classification problems such as landscape land classification [2]; deep learning

Table 1: Variety of algorithms of machine learning technology.

Learning style	Algorithms type	Algorithms
Supervised learning	Regression	Linear regression, polynomial regression, ridge regression
	Classification	Logistic regression, support vector machine, decision tree, *k*-nearest neighbor, etc
Unsupervised learning	Clustering	*K*-means, means shift, fuzzy *c*-means
	Association rule learning	Apriori, frequent pattern growth
	Dimensional reduction	Principal component analysis, linear discriminant analysis

algorithms, such as convolutional neural networks, recurrent neural networks, and generative adversarial networks, have powerful image recognition capabilities [3–5] and are mostly used for rapid identification and information extraction of remote sensing images and street view images [6–10], in which algorithms such as generative adversarial networks also have powerful image generation capabilities [11], which are mostly used in generative design [12]; regression algorithms such as principal component analysis and logistic regression have the ability to automatically associate data and perform functions. The ability of fitting to mine the internal relationship behind the data is mostly used for correlation analysis, such as the research on the driving force of the development of landscape patterns [13–16]; tf-idf, word2vec, BERT, CRF, LSTM in the field of computer natural language processing. Such algorithms have the ability of text recognition and processing and can classify and extract sentiment and other topics from text data in a large number of networks.

In this work, the *k*-means algorithm is used for the first time to perform cluster analysis on the landscape principle design of the urban landscape. And the results of the model are tested by taking Hangzhou Hupao and Beijing Biyun Temple survey image clustering as examples. The results show that the model has a good performance in the application of modern urban landscape design for generating plant landscaping. In addition, this paper also analyzes the application principles of plant landscaping in the urban landscape and the application of plant landscaping in modern urban landscape design.

2. Theoretical Basis of Machine Learning and Principles of Plant Landscaping

2.1. Machine Learning. In the field of landscape architecture, traditional computer technology requires artificially designed computing rules, while machine learning technology has powerful rule learning ability and the ability to capture implicit rules. In landscape architecture work, it is necessary to analyze the site conditions, obtain the law of site changes, and then intervene and guide the site to develop in a specific future direction according to the means of planning and design. Therefore, machine learning has great potential in the field of landscape architecture.

From the perspective of machine learning technology, machine learning technology includes a variety of algorithms with different functions and focuses (Table 1). However, because the design goals of the algorithms in the computer field have less overlap with the landscape architecture design, they cannot directly serve the landscape architecture design, so they are used in the landscape architecture. There are not many algorithms with relatively mature applications. The common application method at present is usually to decompose the planning and design into multiple work steps and then design the corresponding algorithm according to the work target of each step.

2.2. K-Means Algorithm. In the *K*-means algorithm, *K* is the number of cluster centers, and Means is the mean. This algorithm clusters the regional data points through the iterative optimization of the mean and obtains the optimal clustering result. In this article, garden colors are divided into 7 colors. Below are the executor steps of the algorithm. (1) Set $K = 7$. Seven color location data are randomly selected as the initial cluster centers of the seven categories, and the Euclidean distance formula is used.

$$D = \sqrt{(x_i - x_0)^2 + (y_i - y_0)^2}, \tag{1}$$

where D is the distance; x_0 and y_0 is the latitude and longitude coordinates of the center point D; x_i and y_i, is the latitude and longitude coordinates of each noncenter point. Use this formula to calculate the distance from each noncluster center point to the cluster center point, and divide each noncluster center point to the nearest cluster center. (2) After the data are grouped by distance, the mean of the seven groups is calculated, respectively, and the mean of the seven groups is used as the new cluster center. (3) Iteratively calculate the distance from each noncenter point to the new center point using equation (1). (4) Iteratively calculate new cluster centers until each noncluster center data no longer move and the cluster centers no longer change.

2.3. Application Principles of Plant Landscaping in Urban Landscape

2.3.1. Ecological Principles. In the urban landscape design, the application of plant landscaping can not only create a beautiful visual environment, improve the city's ornamental value, but also improve the material environment. In plant landscaping, it is very important to strengthen the plasticity of plants and improve the ecological beauty of the surrounding environment. On the one hand, plants purify the surrounding environment very well by releasing oxygen and absorbing carbon dioxide. At the same time, there are functions such as reducing noise and adjusting the temperature. However, different types of plants have different

growth environments. Once the selected plant species is not suitable for the local ecology, it will have a great impact on its growth. On the other hand, if there is a phenomenon that the community violates the natural development law, there will be serious consequences. Therefore, it is very necessary to scientifically select plant species based on local environmental conditions.

2.3.2. Principles of Practicality. In the application of plant landscaping in urban landscape design, the principle of practicality should also be followed. The so-called principle of practicality means that in the actual process of plant landscape landscaping, some practical functions such as environmental protection should be fully considered. Harmful gases play a good role in purifying the air. If the above practical conditions cannot be met, some practical plants that can play a good role in noise reduction and dust prevention can also be selected as landscaping materials. Therefore, while beautifying the urban environment space, it can also effectively weaken the sense of tension and oppression brought about by the characteristics of urban industrialization, meet people's needs to be close to nature, reduce the urban heat island effect, and enable urban plant landscaping to achieve production and integration. The combination of ornamental and ornamental can give full play to the functional value of urban plant landscape in beautifying, ecological, and environmental protection.

2.3.3. The Selection of Plants Should Be Combined with the Characteristics of the City. In modern urban landscape design, the application of plant landscaping should not only repeat the application of a single plant, but should combine the characteristics of the local city and the actual situation of the landscape, and at the same time consider factors such as soil climate and environment. Therefore, designers need to consider the local plants with strong regionality and show the local characteristics through the planted plants, which can not only create a certain resource space for the local landscape but also allow the planted plants to better adapt to the environment, to further save plant landscaping.

2.3.4. Make Full Use of Ground Cover Plants. Among various types of plants, ground cover plants have their own unique features, such as luxuriant branches and leaves, and strong fecundity. At the same time, they have a very strong antipollution ability, and follow-up maintenance is also more convenient. Therefore, in various designs of the modern urban landscape, planting is almost indispensable, which can give people a harmonious and comfortable look and feel. From the overall look, it also makes the layering of the whole design more prominent, making people shine. The plants above can absorb light energy, and the plants below can loosen the soil surface, adjust the ground temperature, and make the growth environment of the trees above better. In addition, ground cover plants also play an important role in the garden landscape. For example, planting ground cover plants around flower beds and on both sides of the sidewalk can form a sharp color contrast with the flowers and effectively clarify the walking routes of tourists, thereby improving the ornamental value of the landscape and at the same time alleviating people's aesthetic fatigue.

3. Judging the Plant Landscaping Style of Modern Cities Based on Machine Learning Models

3.1. Model Establishment and Training. The data of this experiment are mainly images with latitude, longitude, and elevation information taken through the actual survey of mobile phones. Divided into two groups, one group came from Hangzhou Tiger Pao. The other group came from Biyun Temple in Beijing. The specific technical route is shown in Figure 1. First, the images are read in batches in the Python programming language, because the captured images are about 4 200 pixels 2 400 pixels in size, and color analysis does not require such high precision, so the image size is reduced by compressing the image to save analysis time. Then, set the number of color theme color clusters to 7, that is, obtain 7 theme colors for each image. Colors were classified using the K-means clustering algorithm.

The extraction of the theme color is shown in Figure 2. After extracting the theme color of all images, they are summarized in an array. In the aspect of data enhancement visualization, 2 forms are designed: (1) scatter point form to print the theme color, which can directly reflect the urban color impression. Through the extraction of the urban theme color, the color impression sensory presentation can be used to study the urban color, which can be aimed at different urban spaces and different research times, and to analyze the changes in color. (2) Try to project the subject color of the survey images of the two places into the three-dimensional space and observe the changes of the two sets of data in the three directions of red, green, and blue.

3.2. Model Results. In machine learning clustering, sklearn integrates many clustering algorithms and compares the effects of different clustering algorithms on different data types through the actual operation of the program. In addition to applying survey photos to analyze the urban color environment, you can also use recorded video, extract images at specified frames, and perform the same analysis. In the specific data analysis, the theme color of each image can also be placed on the coordinate points of its latitude and longitude, and the clustering algorithm can be used again to cluster the areas with similar color values in the space, so that the urban color characteristic areas can be classified. And the POI data reflecting urban functions, Weibo, WeChat, and other data reflecting urban social relations are combined and analyzed to find the internal mechanism of urban color space distribution characteristics.

The clustering results of the research images of Hangzhou Hupao and Beijing Biyun Temple, and the color impression after printing the theme color in scatter form are shown in Figure 3. Hupao's theme color is gray and dark (the color of the building), mixed with green and green vegetation and blue

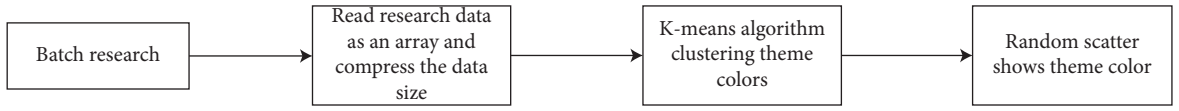

Figure 1: The technical route of using *K*-means clustering algorithm.

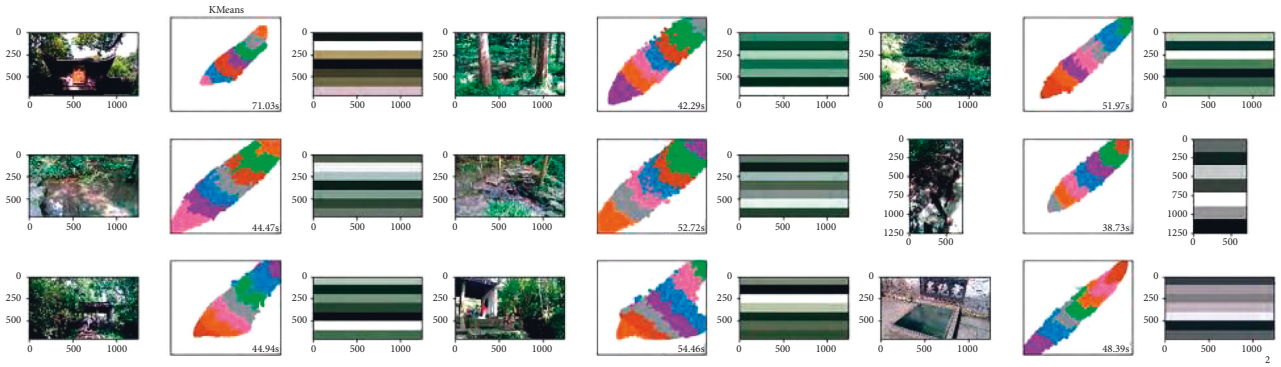

Figure 2: The extraction of the theme color.

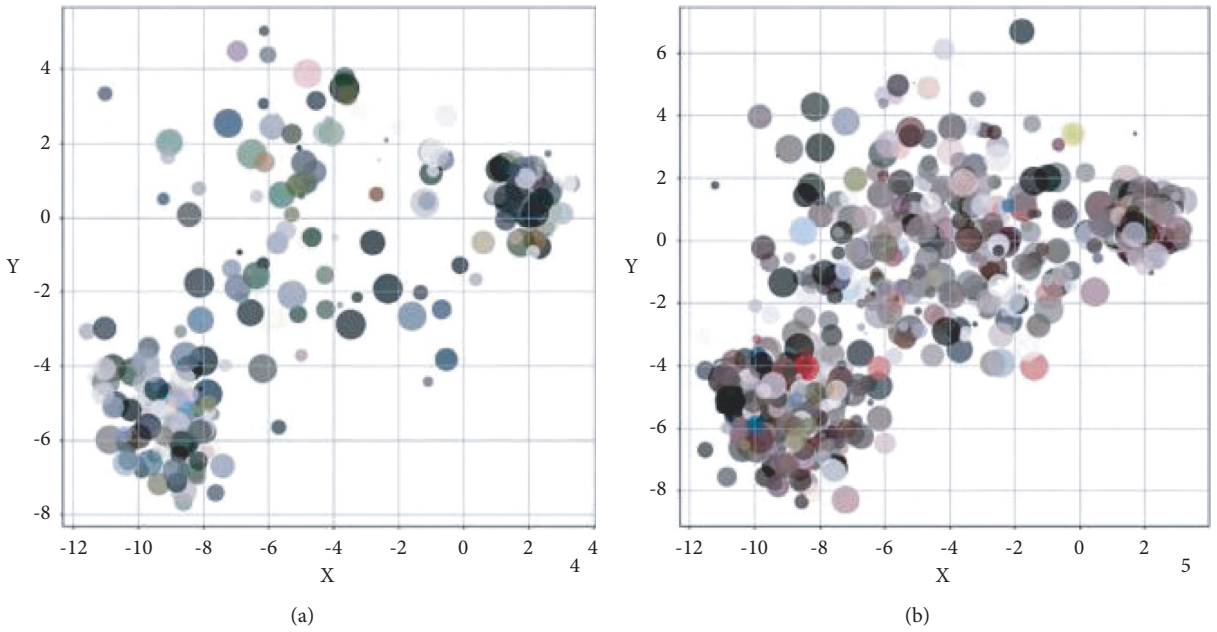

Figure 3: The clustering results of the research images of Hangzhou Hupao and Beijing Biyun Temple, and the color impression after printing the theme color in scatter form.

sky. Simple and elegant Biyun Temple because the building itself is mostly red, after interspersed with vegetation and the sky, the overall feeling is gorgeous and gorgeous. Through these data visualization methods, the urban color characteristics of the study area can be more intuitively reflected. If the number of research areas surges, automated batch processing can be achieved according to the established model, such as studying the color characteristics and distribution relationships of different areas of the city. Data containing color information (RGB) is projected into three-dimensional space. The changes in the red, green, and blue color components can be grasped by judging the distribution of the colors of the two regions in the three-dimensional space domain. The color tendency of Beijing Biyun Temple is higher in the red value, while the 3-component of Hangzhou Hupao color tends to be lower. In the analysis, the color can also be converted to HSV (hue, saturation, value) and projected into the three-dimensional space domain to analyze the relationship between hue, saturation, and lightness.

4. The Application of Plant Landscaping in Modern Urban Landscape Design

4.1. Tree Landscaping. In large garden scenic spots, all kinds of towering and lush trees will always bring people many different impressions. For example, the lush ginkgo, with its

proud standing posture, brings people a beautiful feeling. It has long been called the Gongsun tree. The planting of ginkgo in the garden landscape not only reflects the virtues of the predecessors planting trees and the later generations enjoying the shade in traditional Chinese culture but also implies people's yearning for a better life in the future. The willow tree is deeply loved by garden designers because of its gentle and graceful tree shape. In spring, it is praised for its willows that are drunk with spring smoke. In summer, it is called ten thousand hanging green silks. In the winter, the weak warbler with green silk strips presents the beauty of ancient charm in different seasons. Because of its tall and straight leaves and sparse branches, the king coconut tree is often used as a street tree to green roads. The curved branch shape of mountain peach, the arch branch shape of welcoming spring, the umbrella shape of acacia, and the clump shape of the Chinese rose can all bring people different visual enjoyment.

4.2. Make Plant Landscaping in Combination with Different Terrains. In the actual plant landscaping, it is necessary to combine the different spatial topography of the city, so as to effectively highlight the natural characteristics of landscaping. For example, some trees can be planted around the ridgeline, and some short shrubs can be planted in the position of the hillside ravine. Through this landscaping configuration, it can not only effectively demonstrate the tall and straight posture of the mountains but also make the entire urban environment more harmonious and increase the three-dimensional sense. On this basis, the characteristics of some buildings such as urban pavilions and pavilions can also be combined, and plants can be arranged on the top of the mountain to promote the two to set off each other and complement each other. When creating a waterside flower border landscape by the water, make a good choice of aquatic plants, the more common ones are reed bamboo, water lily, barracuda, and parasol. To ensure a good reflection effect, it is not advisable to plant too many plants underwater. On the banks of the embankment, some trees can be planted, and the trees are sparsely distributed to form a beautiful reflection in the water.

4.3. Follow the Aesthetic Principles of the Plants Themselves for Landscaping Design. First of all, in some areas such as the corners of buildings and roads in the city, it is necessary to weaken the sharp corners to reduce the visual rigidity. In landscaping, the combination of flat slope and arbor and irrigation can be used to plant some beautiful plants, such as cedar, sycamore, and pentagonal maple. If the selected seedlings are plants with high branch points, try planting multiple seedlings in the same tree pond. At the same time, carry out scientific planting, let them grow together into a large canopy, and effectively weaken the corners. On the other hand, it is also possible to make a reasonable blank of the landscape with the help of the blanking technique of traditional Chinese painting. For example, in a relatively empty square, if you add a few delicate trees to embellish it, it can give people an open and comfortable look. It fully embodies the principle of balanced aesthetics.

4.4. Maintaining the Stability of Native Plant Communities. Before introducing new plants, we must first ensure that the existing plant community is in a relatively stable state. Therefore, for the introduced new species, the relevant departments must do a good job in quarantine work and make a good estimate of their reproductive capacity, so as to avoid a large number of reproduction and spread after they are introduced into the urban landscape, which will cause damage to the balance of the local plant community and ecological structure very serious impact. Maintaining the stability of local plant communities can further ensure the visual effects and ecological benefits of urban plant landscaping. On the other hand, weeds should be cleaned regularly to prevent the problem of flooding due to their tenacity, and the affected areas should be restored and protected. At the same time, it is necessary to fully develop the nursery cultivation industry and market, so that plant landscaping can choose more plant varieties.

4.5. Shaping the Urban Landscape in Combination with Local Urban Culture. The culture of each city is different. Nowadays, people have begun to attach great importance to the inheritance and protection of urban culture, as well as the continuation of historical development. Therefore, in the urban landscape design, it is necessary to combine the local urban history and culture, excavate the connotation, present the cultural heritage of the city to the greatest extent, and give the city the driving force for continuous development. Therefore, in the modern urban landscape plant landscaping, it is necessary to combine urban culture, conform to the current development law of our country, and avoid destroying the surrounding ecological environment.

5. Conclusion and Future Prospects

Artificial intelligence technology based on machine learning is gradually applied to the analysis and evaluation of landscape architecture with its efficient data processing capabilities and implicit rule capture capabilities and has initially replaced some simple repetitive labor at this stage. Algorithmic generative design based on deep learning takes the creativity of artificial intelligence a step further. The cleaning and selection of data and the manual intervention of algorithms are the core bottlenecks at present.

The cleaning and selection of data are a technical challenge. Artificial intelligence is basically the exchange of artificial intelligence for intelligence, and it is supported by a large amount of basic data work (such as manual annotation). Problems such as noise and lack of data are frequent at this stage. In this context, designers appear as data analysts, and artificial intelligence methods aimed at replacing repetitive work have brought more planning and analysis and repetitive work. However, with the improvement of technology in the future, the emergence of more excellent algorithms and data sources will gradually solve the current

problems and allow designers to return to planning and design.

The manual intervention of the algorithm is a difficult problem in the application method, which directly affects the role of artificial intelligence and designers. This question is related to the question of how much artificial intelligence should be in the design. This also involves a series of questions such as whether the artificial intelligence analysis results are reliable, whether the output results are correct, and how to define correctness? As mentioned above in the planning case of Rome railway station and the case of plant configuration, the architectural form needs to conform to the form of the building base and at the same time be similar to the surrounding architectural texture. Under the constraints of these two goals, deep learning can balance the relationship between the two, aiming at approximating the base shape and searching the building database for matching, comparing, and iterative cycles. The optimal solution can be obtained only by approximating the base shape infinitely. In the plant configuration project, plants need to meet conditions that are easy to quantitatively explain such as sunshine, climate, and configuration mode. However, under this condition, attributes such as plant species, plant height, and crown width can only be constrained within an interval, so the output results are still very large. Therefore, whether the output result is correct is related to whether the target is abstract. From the computer's point of view, it is easy for computers to calculate quantitative problems with clear standard goals and regard the goals as correct. In the face of abstract problems, it is difficult for the computer to judge whether it is correct, but for designers, this is also an open problem. To this end, different scholars have made preliminary explorations, and for example, in the case of plant configuration, the abstract plant configuration theory is quantitatively explained and constrained. In the planning case of the urban central axis, the evaluation system is used to constrain the abstract scheme selection problem; Tang Jingxian's streetscape evaluation research combines the subjective evaluation system with the objective analysis results of streetscape information to realize the artificial correction of machine learning perception evaluation research. The above methods are currently tried by designers. Efforts to revise AI-generated results are also responses to abstractions in design.

To sum up, at present, plant landscaping has been widely used, which greatly improves the urban environment, allows people to live in a comfortable and environmentally friendly living environment, and further promotes the development of urban construction in China. At this stage, plant landscaping has become an indispensable part of urban landscape design. In the process of designing urban landscapes, designers must combine with more ecological elements and use different plant characteristics to make plant landscaping. The scenery is more suitable for city life.

In the future, with the training and learning of a large amount of data, the creativity of artificial intelligence will gradually increase. Landscape architecture is a subject highly related to human subjective aesthetics. In order to avoid over-reliance on artificial intelligence in planning and design, it leads to the patterning and standardization of output results. Future research should distinguish between the repetitive and simple labor that should be performed by artificial intelligence in the planning and design process and the part that requires the designer's experience and judgment, and let artificial intelligence technology assist the design instead of leading the design.

Data Availability

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding this work.

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