Research on Image Recognition Effect Based on KNN Algorithm and Decision Tree Algorithm

Abstract

As a very important technology in artificial intelligence, computer image recognition technology has been widely used in Internet search engine, intelligent transportation, biomedicine, remote sensing analysis, automation control and other fields. In agricultural production, it can monitor the growth process of agricultural operations, control crop diseases and insect pests, automatic identification of animal husbandry, intelligent identification and automatic positioning of license plates in the field of intelligent transportation, and provide clear and intelligent images in the field of biomedicine. Studying computer image recognition technology and mastering the use of computer image recognition technology tool class library are of great significance for fully understanding and using computer image recognition technology and realizing its application in real life.

Introduction

Computer image recognition has a wide range of applications, such as Internet search, intelligent transportation, biomedicine, remote sensing analysis, intelligent control and other fields. Computer image recognition technology solves the problem that people use cameras and computers instead of human eyes to acquire, recognize, track and measure the target images, and compress, enhance, restore, image and recognize the acquired images. Nowadays, computer image recognition technology has a wide range of applications. In agricultural production, computer recognition technology can be used to monitor the growth of agricultural operations, agricultural picking, pest prevention and other links. In the field of intelligent transportation, intelligent recognition and automatic positioning of license plates are realized. In the manufacturing industry, the intelligent automatic processing of parts production is realized by computer image recognition technology. In the biomedical field, medical image acquisition can be realized, and clear and intelligent medical images can be obtained. The remarkable effect of image recognition is the accuracy of recognition. In order to improve the accuracy of image recognition, artificial intelligence technology has begun to shine brilliantly in the field of computer image recognition.

Literature Review

Using machine learning to improve the accuracy of image recognition is widely used in various fields of life and research, whether in the medical field or fashion field. Scientists use the handwritten numbers in MNIST database to study image recognition. This data set is widely used and trained by many scientists. MAN, LEE, WANG, CAO and KHOO. (2013) In order to improve the accuracy of handwritten numeral recognition, an

optimal weight learning machine of feedforward network with a single hidden layer was developed for data training. This model can optimize the training globally, and the accuracy of image recognition can be improved by using fewer hidden nodes. Further deep learning algorithms have also played a great role in the field of medical image recognition. Allyn, Allou, Vidal, Renou and Ferdynus. (2020) used convolutional neural networks to recognize dermatology images, and the final test results were generally above 80%, which got a good experimental result. Gu, Zhang, Han, Li, Chen and Lo. (2019) applied the image recognition method of machine learning to the field of cell classification laissez-faire. They designed an image-guided cell classification system, improved the image hungry feature lifting method, and finally made the cell classification result better, and also realized the offline processing of the system. Rosam, Reynolds, Alexander, Gadegaard and Ghaemmaghami. (2017) also applied the machine learning method to identify cells. They used the machine learning method to identify different phagocytes according to their cell size and surface morphology. The final experiment found that the identification accuracy of two phagocytes reached over 90%.

Zhuo, Zhang, Zhao and Zhao. (2013) used decision tree to identify images. They proposed a method for identifying pornographic images, optimized the method of image feature extraction, improved the accuracy of feature extraction, and built a multi-cost sensitive decision tree identification system. Finally, it was found that the improved method was 3 times faster than the traditional image recognition method, and performed well in accuracy. Ginris, Amaral, Nicolau, Coelho and Ferreira. (2007) used a variety of machine learning methods to identify protozoa and metazoan, including discriminant analysis, neural network and decision tree to train and compare the models respectively. Finally, it was found that other methods except decision tree performed well. Das, Das, Panda and Sabut. (2019) put forward a method of using the combination model of multi-layer perceptron and decision tree to recognize the CT images of liver cancer. This method can extract the features of the images well and learn the features well. The final result shows that its accuracy rate reaches 89.15%, which is a good method. Chen, Xu, Ding and Luo. (2018) studied the effect of improving image recognition by improving KNN algorithm, and proposed a KNN extension method for image recognition. A new multiplication and iteration method was used to train and solve the model. Finally, it was found that the proposed method and model showed fast convergence speed and good accuracy in face image recognition. Wu. (2021) proposed a method of combining KNN and PSO algorithm to recognize emotional pictures. Finally, it was found that PSO algorithm can effectively improve the accuracy of KNN for picture recognition. Duan. (2018) discussed the recognition algorithm of English letters and numbers based on KNN, and proposed several steps of image recognition, including determining the basic category information of images, and then comparing the training images with the recognized images to determine the closest results. Finally, it was found that the algorithm performed well in the tests of different types of image data. This paper will use KNN algorithm and decision tree algorithm to train image data, and adjust and compare the parameters of KNN and decision tree to get a better training parameter and model.

Methodology

KNN algorithm is the K nearest neighbor classification algorithm. It is a traditional classification method in machine learning, that is, each sample can be represented by the K nearest neighbors of the sample. According to the calculation of Euclidean distance, the types of samples are classified into the types of the samples closest to others, which means that the classified samples also have the characteristics of the samples closest to others. Therefore, the classification of KNN is mainly related to the distance between its adjacent samples.

Decision tree is also a classical machine learning algorithm, because it contains root nodes and leaf nodes, so it is called decision tree. The running process of the decision tree algorithm is a process of recursively selecting features. The training data is segmented, so that each data can have an accurate classification process. The key of decision tree is to determine the depth of numbers, which represents the recursion degree of learning, and the other is to determine the number of leaf nodes, which represents the number of features.

In order to evaluate the performance of the model, we use five commonly used classification performance indicators in the literature to evaluate the prediction ability of the model. They are Confusion Matrix, Recall, Precision, Accuracy and F1 score.

Results and Analysis

Data source

The data source for this paper is the fashion mnist dataset from the keras library for empirical analysis. the fashion dataset from the keras library is often used in image classification case studies. The dataset includes a total of ten fashion categories and a total of 70,000 grayscale images.

Data preprocessing

Partitioning of data sets

The dataset in this paper has a total of 70,000 images, of which 60,000 grayscale images are training set and the rest are used for prediction.

Standardized processing

Before applying data to machine learning models, it is very important to standardize data processing. Because each attribute of data usually has different dimensions, if the input features are not measured at the same scale, the features with smaller values may be dominated by a single feature with larger values, which makes the data not comparable. Therefore, in machine learning models, normalization of the data is usually chosen. The

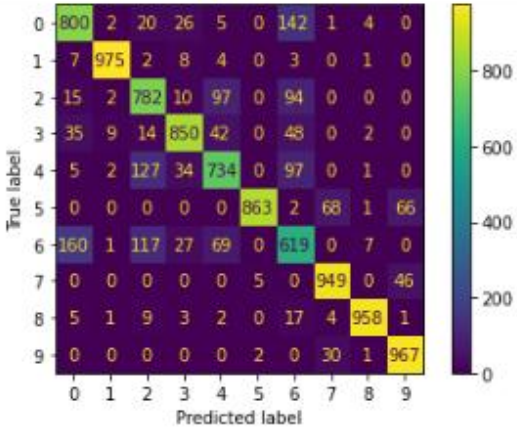
standardization process is as follows.

$$\hat{x}_k = \frac{x_k - \frac{1}{n}\sum_{k=1}^{n} x_k}{\sqrt{\frac{1}{n-1}\sum_{k=1}^{n}\left(x_k - \frac{1}{n}\sum_{k=1}^{n} x_k\right)^2}}$$

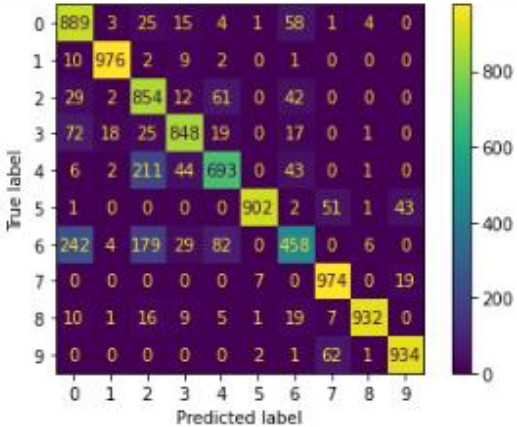
KNN model for image classification

After the data preprocessing process, an appropriate prediction model will be established and trained for the data. In this section, the standardized training set data will be input into KNN model for training to obtain the prediction model. Then the test set data is input into the trained prediction model. Since different parameters and different distance measures will lead to different results of the KNN model, this paper will construct prediction models with different parameters and distance measures and evaluate the prediction results to investigate the best model in the given data set. In the following, the evaluation metrics of the prediction results of the KNN model with different parameter settings are shown. Fig. 1 shows the confusion matrix of prediction results of neighbors with different values when the distance measurement method of KNN model is Euclidean distance. In the confusion matrix diagram, the horizontal and vertical coordinates represent the predicted and true labels, respectively. Figure 2 shows the confusion matrix of prediction results of neighbors with different values when KNN model measures the distance as Manhattan distance. Table 1 shows the prediction results of each prediction model with different parameters and distance measurement methods.

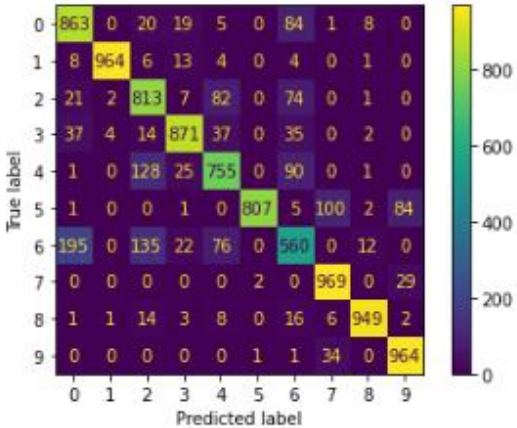
Number of nearest neighbors=1



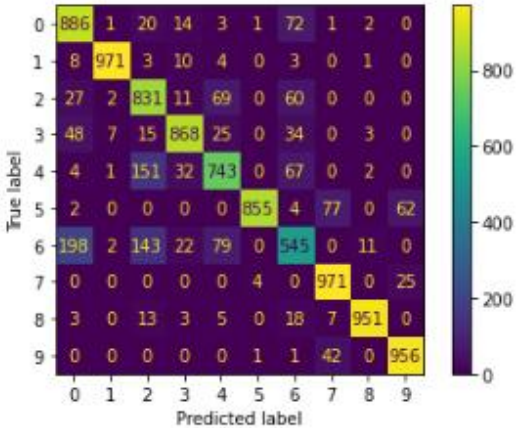
Number of nearest neighbors=2



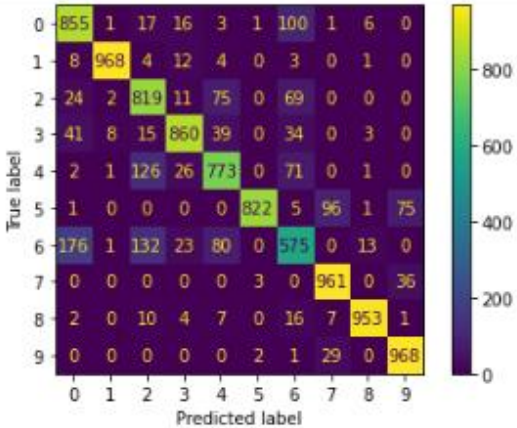
Number of nearest neighbors=3



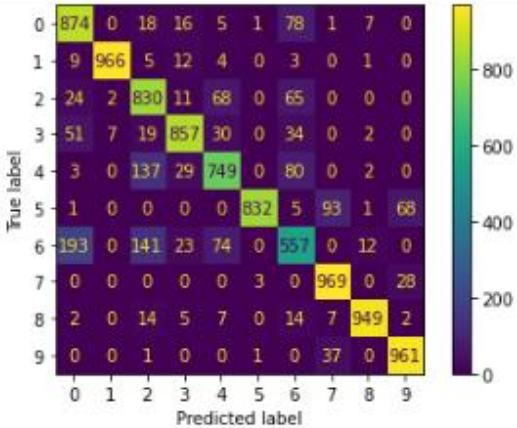
Number of nearest neighbors=4



Number of nearest neighbors=5



Number of nearest neighbors=6



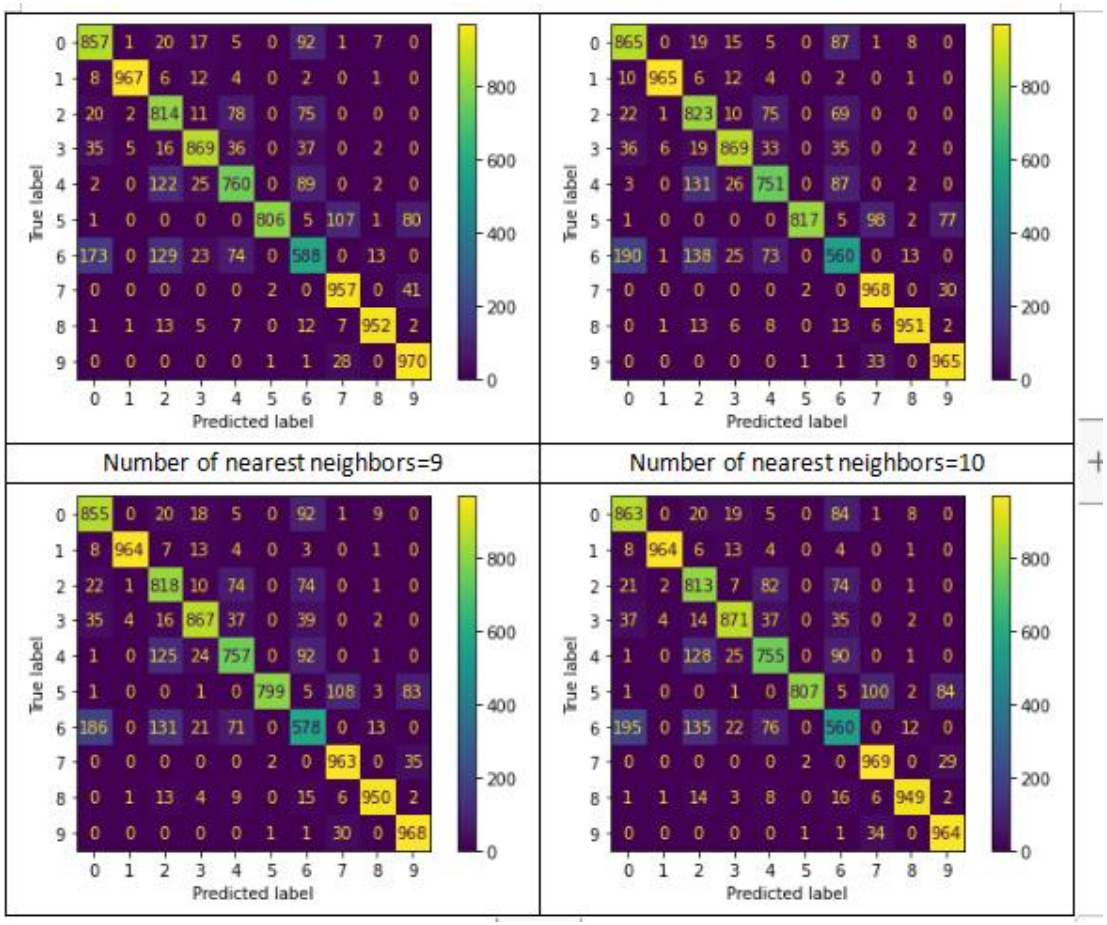
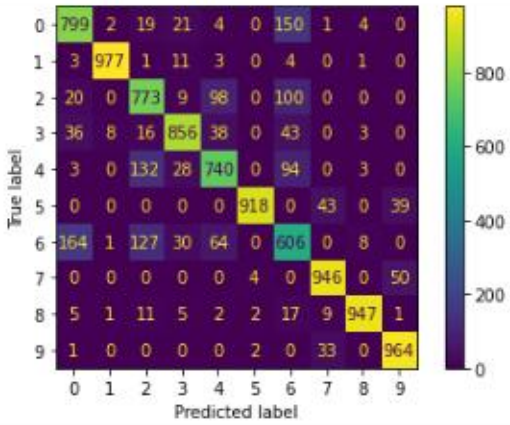


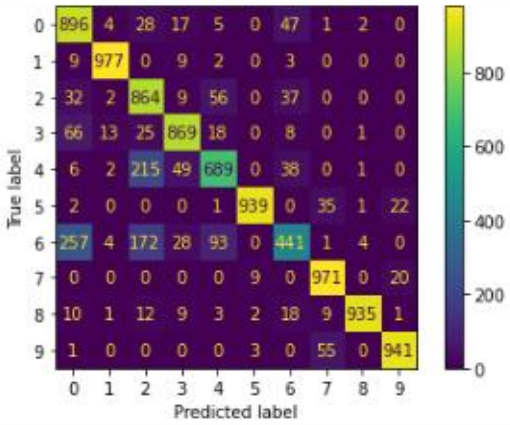
Fig.1 Distance metric = Euclidean distance, Confusion matrix of prediction results for neighbors=1-10.

The confusion matrices obtained using different nearest neighbor numbers according to Figure 1 are not the same. In Figure 1 when the true and predicted labels are the same means that the classification is correct, which is shown in the confusion matrix as the sum of the numbers on the diagonal downward. From Figure 1, it can be seen that when the distance metric is Euclidean distance, the number of images correctly predicted is the highest when the number of nearest neighbors is 4, which is 8577.

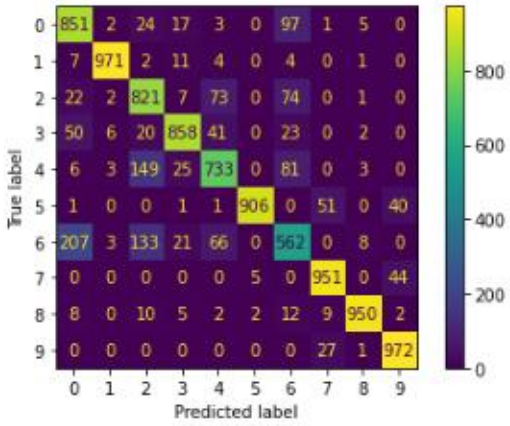
Number of nearest neighbors=1



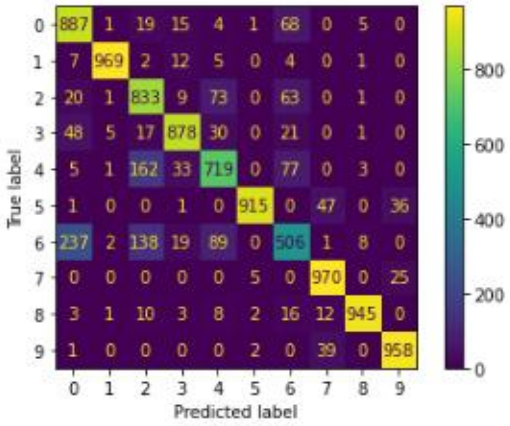
Number of nearest neighbors=2



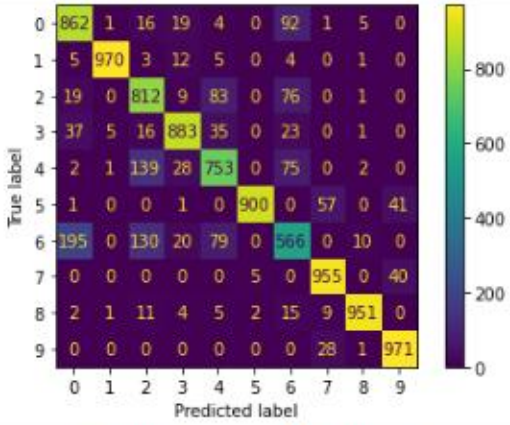
Number of nearest neighbors=3



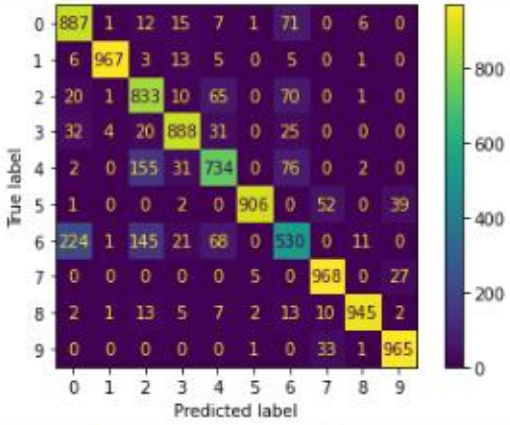
Number of nearest neighbors=4



Number of nearest neighbors=5



Number of nearest neighbors=6



Number of nearest neighbors=7

Number of nearest neighbors=8

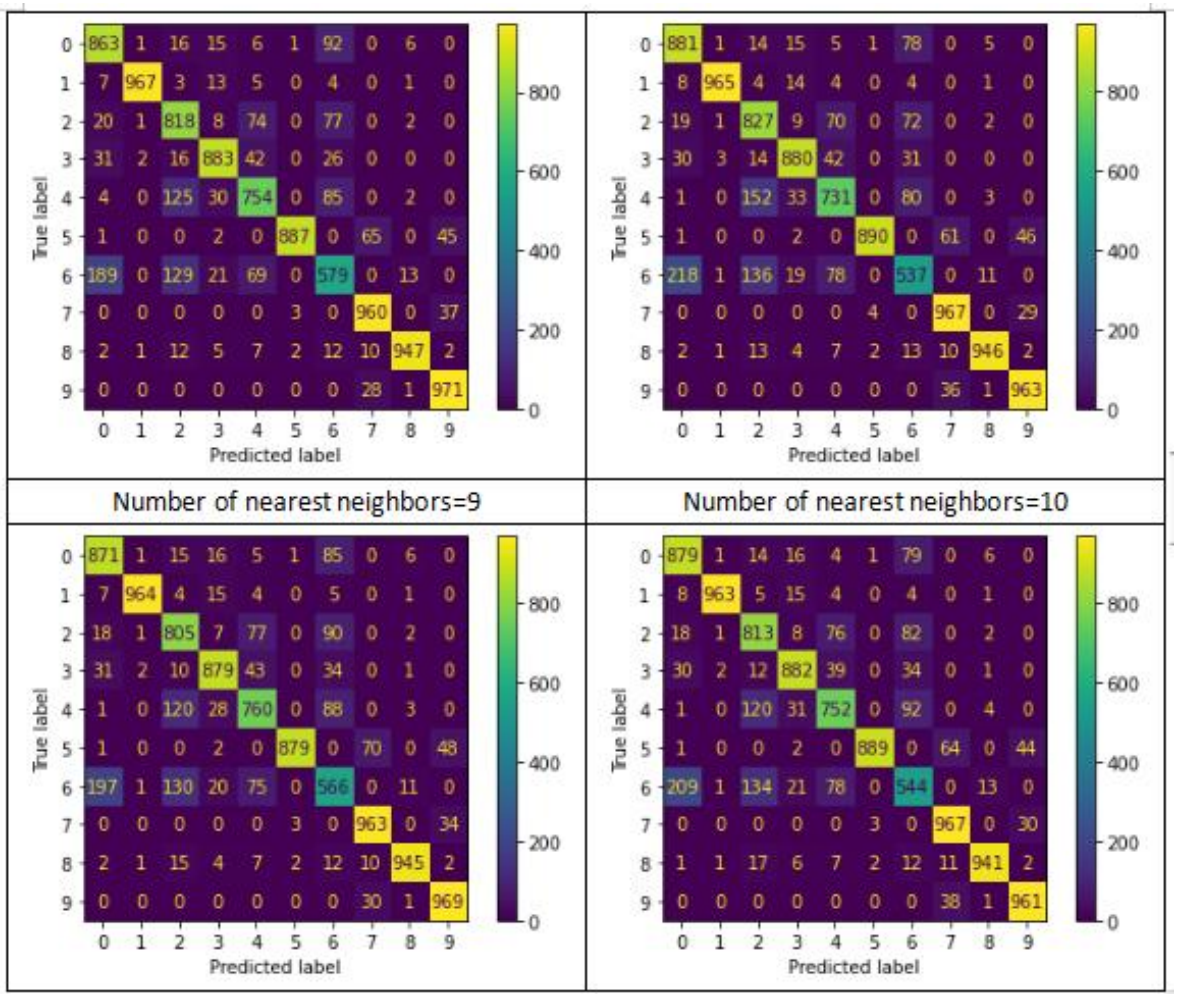


Fig.2 Distance metric = Manhattan distance, Confusion matrix of prediction results for neighbors=1-10.

Figure 2 shows the confusion matrix plot for different number of nearest neighbors when the metric is Manhattan distance. From the figure, we know that the number of correct images is 8629 when the distance metric is Manhattan distance and the number of nearest neighbors is 7.

Table 2 The Performance of KNN model with different parameters.

Number of neighbors	Euclidean distance				Manhattan distance			
	Recall	Precision	Accuracy	F1 score	Recall	Precision	Accuracy	F1 score
1	0.8497	0.8527	0.8497	0.8503	0.8526	0.8551	0.8526	0.8534
2	0.846	0.8520	0.846	0.8429	0.8522	0.8586	0.8522	0.8483
3	0.8541	0.8575	0.8541	0.8539	0.8575	0.8597	0.8575	0.8569
4	**0.8577**	**0.8604**	**0.8577**	**0.8563**	0.858	0.8595	0.858	0.8559
5	0.8554	0.8578	0.8554	0.8546	0.8623	0.8634	0.8623	0.8615
6	0.8544	0.8574	0.8544	0.8534	0.8623	0.8638	0.8623	0.8607
7	0.854	0.8570	0.854	0.8534	**0.8629**	**0.8643**	**0.8629**	**0.8623**
8	0.8534	0.8562	0.8534	0.8524	0.8587	0.8601	0.8587	0.8573
9	0.8519	0.8553	0.8519	0.8513	0.8601	0.8615	0.8601	0.8595
10	0.8515	0.8545	0.8515	0.8506	0.8591	0.86	0.8591	0.858

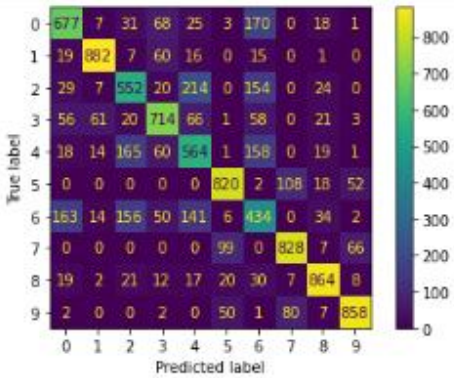
Table 2 shows the performance results of the KNN model with different parameters. As can be seen from Table 2, the optimal parameters for the KNN model are: the metric distance is the Euclidean distance and the number of nearest neighbors is 4. This is when the model has the highest recall of 0.8577, the highest accuracy of 0.8604, and the highest accuracy and F1 score. The best model when the metric distance is Manhattan distance is 7. This is when the model has the highest evaluation metric.

Using Fig. 1, Fig. 2 and Table 1, we can know that the KNN model classifies the highest number of images correctly when the distance metric is Euclidean distance and the number of nearest neighbors is 4, which is 8577. The KNN model classifies the highest number of images correctly when the distance metric is Manhattan distance and the number of nearest neighbors is 7, which is 8629. The model has the highest evaluation metric of any, with a recall of 0.8629, accuracy is 0.8643, precision and recall are the same, and F1 score is 0.8623. Comparing the results of the model with different distance metrics, we can conclude that the best parameters for this experiment in the KNN model are: distance metric is Manhattan distance and the number of nearest neighbors is 7.

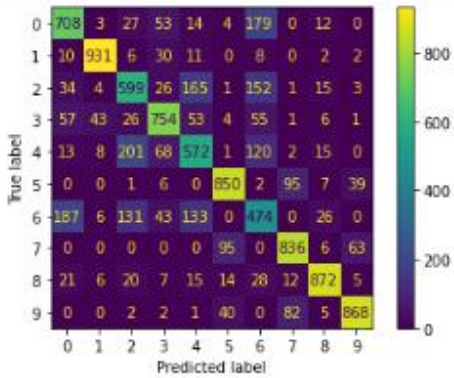
Decision tree model for image classification

After the data has been normalized, a suitable prediction model is built and trained for the data. In this section, the normalized training set data is fed into the decision tree model for training to obtain the prediction model. The test set data is then fed into the trained prediction model. In order to investigate the effect of different parameters on the model effect, the prediction models are constructed with different parameters and the prediction results are evaluated to investigate the best model for the given dataset in this paper. In the following, the evaluation metrics of the prediction results of the decision tree model with different parameter settings are shown. Figure 3 shows the confusion matrix of the prediction results for different parameter settings of the decision tree model. The results of other evaluation metrics are given in Table 2.

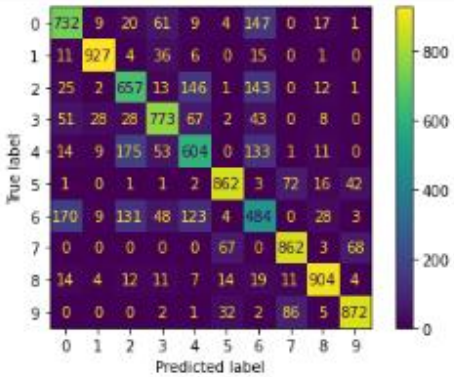
Depth of the tree=3



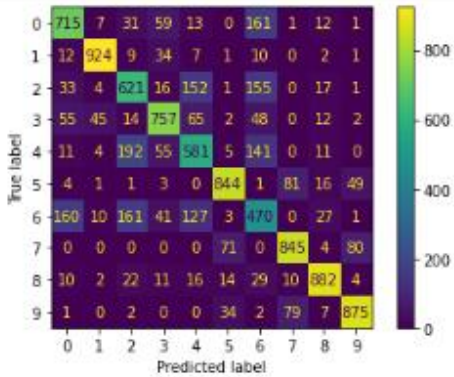
Depth of the tree=5



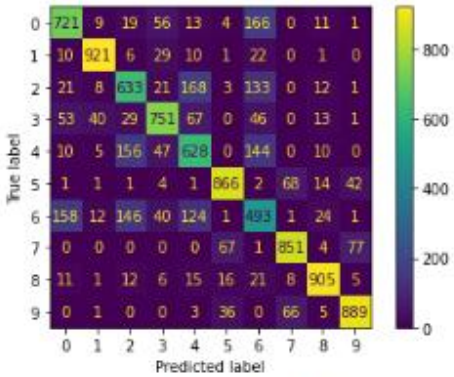
Depth of the tree=8



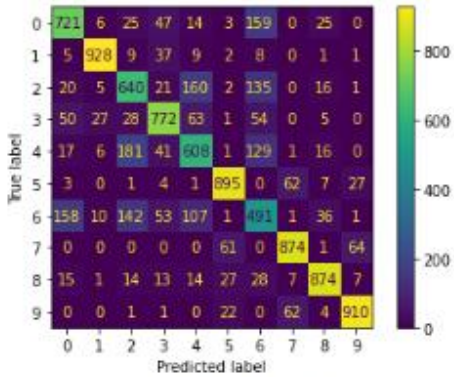
Depth of the tree=10



Depth of the tree=15



Depth of the tree=20



Depth of the tree=25

Depth of the tree=30

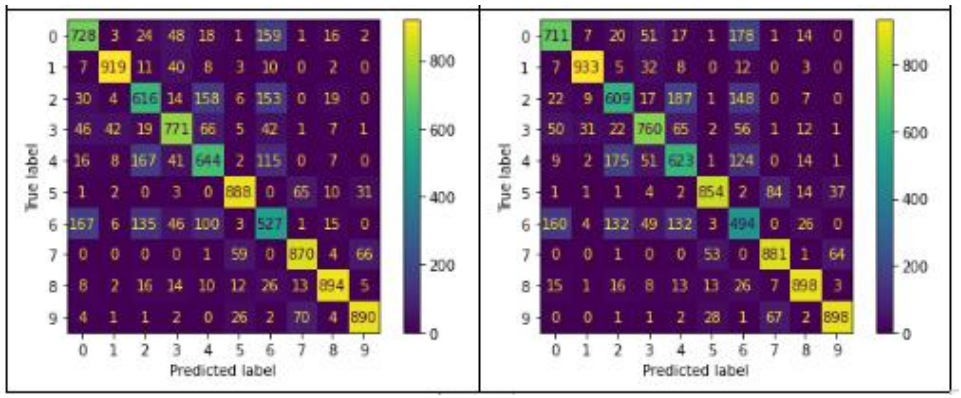


Figure 3 shows the confusion matrix plot for applying different tree depths to the decision tree model. The maximum number of correctly predicted images is 7747 when the depth of the tree is 25.

Table 3 The Performance of Decision Tree model with different parameters.

max depth	Recall	Precision	Accuracy	F1 score
3	0.7193	0.71	0.7193	0.7195
5	0.7464	0.7472	0.7467	0.7464
8	0.7677	0.7675	0.7675	0.7677
10	0.7514	0.7524	0.7518	0.7514
15	0.7658	0.7671	0.7658	0.7664
20	0.7713	0.7718	0.7713	0.7715
25	**0.7747**	**0.7759**	**0.7747**	**0.7753**
30	0.7661	0.7683	0.7670	0.7661

Table 3 shows the evaluation metrics of the prediction results of the decision tree model for different values of the parameters. From Table 3, it can be seen that the best model is parameterized by a tree depth of 25. At the end of the experiment, the KNN model with the best parameters (best parameters: distance measure is Manhattan distance) is compared with the decision tree model (best parameters: tree depth is 25) and the KNN model performs better. The number of accurate classifications for the best KNN model is 8629, while the number of nearest neighbors for the

decision tree model is only 7747. The KNN model outperforms the decision tree model in all other evaluation metrics.

Conclusion

Image recognition belongs to the category of computer vision in the field of artificial intelligence, which covers image matching, image retrieval, face detection, pedestrian detection and other technologies. Computer image recognition technology is widely used in agriculture, intelligent transportation, biomedicine and other fields. It can monitor the growth of crops, prevent diseases and pests, intelligently recognize license plates, automatically locate license plates, and provide clear and intelligent images in biomedicine. In this paper, we apply KNN model and decision tree model to classify images based on fashionable datasets in keras library and explore the classification prediction performance of these two models by comparing the classification prediction results. Before starting the experiments, this paper firstly describes the background of image classification and reviews the relevant literature studies in the field of image classification. Then, in order to make this paper more readable, we give a brief introduction of the two models used in this paper, including their principles and applications. After describing the background and related theoretical studies, we start to enter the empirical analysis section. In the analysis of the examples, first, we logged into the keras library and found the fashion dataset, which is often used in image classification case studies. The dataset has a total of 70,000 images, which are divided into 10 categories. The dataset was then divided into two parts, a training set and a test set, following the general data processing process of machine learning methods. The training dataset is fed into a KNN model and a decision tree model with different parameters, respectively. The test dataset is fed into the trained model and each evaluation index of the prediction results is calculated. By comparing the evaluation indexes of the prediction results of the KNN models with different parameters, it is found that the model works best when the distance measure is Manhattan distance and the number of nearest neighbors is 7. By comparing the evaluation indexes of the prediction results of the decision tree model with different parameters, it is found that the model works better when the depth of the tree is 25. Finally, comparing the best KNN model with the best decision tree model, we find that the KNN model (with parameters: distance metric as Manhattan distance; number of nearest neighbors as 7) has the best prediction results.

References

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