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A Comprehensive Evaluation of Machine Learning and Deep Learning Methods for Image Recognition

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Abstract:

Image processing is a critical aspect of image recognition, and traditional machine learning models such as K-Nearest Neighbors (KNN), Bayesian networks, and Support Vector Machines (SVM) have demonstrated various advantages in this field. However, the introduction of deep learning algorithms, particularly Convolutional Neural Networks (CNNs), has significantly enhanced the efficiency and accuracy of image recognition by reducing human intervention in feature extraction. CNNs offer a simplified structure, fast learning capabilities, and high recognition rates, making them widely applicable in image processing and pattern recognition. This paper highlights the superior performance of CNNs compared to traditional machine learning methods and discusses their potential for further research in improving recognition accuracy in future applications.

Keywords:

Image Recognition Algorithm; Convolutional Neural Network; Various Algorithms based on Artificial Intelligence; Basic Research.

1. Introduction

In image recognition, image processing is particularly critical. Traditional machine learning image recognition models, K-nearest (KNN), Bayesian networks, support vector machines (SVM), etc., still have various advantages. Using deep learning algorithms can reduce the impact of human factors. Convolutional Neural Network (CNN), as one of the representatives of deep learning algorithms, has a relatively simple structure and strong applicability. In the development of the past few years, it has a wide range of applications, especially in image processing and pattern recognition[1]. Since the introduction of deep learning algorithms, the complex feature extraction has been simplified and abstracted, and it has the advantages of fast learning, less time-consuming, and high recognition rate.

2. Analysis and development trend of research status at home and abroad

Image recognition technology is an important field of artificial intelligence. It has important research and application value in many fields. As the data throughput and computing power of computers continue to grow, the research on human visual patterns continues to deepen. Rely on efficient algorithm design and use large amounts of data for learning and training. Since the introduction of deep learning algorithms, it has brought new vitality to image recognition. The research of convolutional neural network and its application in the field of image recognition is to apply convolutional neural network to image recognition, in the hope that it can be automatically recognized through machine learning, thereby reducing the task of image recognition, while providing more objective The results of the analysis. In image recognition, image processing is particularly critical.

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With the continuous deepening of research on convolutional neural network technology, the application fields of this technology are becoming wider and wider. Convolutional neural network is a pattern classification method developed in recent years, which combines neural network technology and deep learning theory. Convolutional neural network has good learning ability for high-dimensional features and better generalization ability. It has been widely used in image recognition, speech recognition, pedestrian detection and other fields. It has shined in recent years. Almost all important breakthroughs in image and speech recognition are made by convolutional neural networks, such as Google's GoogleNet, Microsoft's ResNet, etc. AlphaGo, which defeated Li Shishi, also used this network[2].

3. Traditional machine learning image recognition model

3.1 K Neighbor (KNN)

KNN classifies the sample to be tested by calculating the similarity between the sample data to be tested and the different types of data points in the training data. The commonly used distance measurement formula of KNN algorithm is Euclidean distance.

$$d(X,Y)=\Sigma_{i=1}||xi-yi||2$$

The algorithm flow is as follows:

step1: Calculate the distance between the feature vector of the test set and the feature vector of the training set.

step2: Sort according to distance.

step3: Select the nearest K points.

step4: Calculate the frequency of occurrence of the category of the first K points.

Step5: Count the category with the highest frequency among the first K points as the classification category of the test set.

3.2 Bayesian network

The Bayesian classification method is based on the probability classification model, and the classification performance of the Bayesian method mainly depends on the accuracy of the estimated conditional probability items. When the training data is scarce, the estimation accuracy of these conditional probability items is low, which leads to the degradation of the classification performance of the naive Bayes method. In the experiment, the classification method of the naive Bayes model of polynomial distribution is adopted.

The algorithm flow is as follows:

step1: Let $x \in \{a1,a2,...,am\}$ be a test set, and a is the feature vector of x.step2:

There is a category set $C=\{y1,y2,...,yn\}$.

step3: Calculate P(y1|x), P(y2|x),...P(yn|x)

step4: If $P(yk|x)=\max\{(y1|x),P(y2|x), \ldots P(yn|x)\}$, then $x \in yk$.

3.3 Support Vector Machine (SVM)

Support vector machine (SVM) realizes nonlinear decision-making in the original space by constructing a hyperplane in a high-dimensional space. SVM is a learning algorithm based on statistical learning theory to solve the problem of small sample classification, which can overcome

the shortcomings of traditional artificial neural networks and other algorithms. SVM uses a classification process from simple to complex, and has a good generalization ability.

4. Convolutional neural network for image recognition

Use convolutional neural network algorithms to realize image recognition. Convolutional neural networks generally consist of a data input layer, a convolutional layer, a pooling layer, a fully connected layer, and an output layer. Convolution operation process: multiply the elements corresponding to the matrix by the elements corresponding to the convolution kernel, then add all the multiplied elements, and assign the added result to the center pixel. In deep learning, the convolutional layer can automatically extract image features, so deep learning avoids the cumbersome requirement of extracting a fixed feature [3].

The input layer of the convolutional neural network can directly process multi-dimensional data. Its main task is to read image information, and the number of neurons in this layer is closely related to the dimensionality of the image. Similar to other neural network algorithms, the input features of convolutional neural networks need to be standardized. The standardization of input features can improve the operating efficiency and learning performance of the algorithm [4].

Convolutional layers are used for feature extraction in convolutional neural networks. Because the convolutional neural network first performs local perception of a feature in the image each time, and then performs a comprehensive operation on the local features at a higher level, so as to obtain the desired global information. The convolutional layer in the convolutional neural network is composed of multiple convolutional units, and the purpose is to realize the convolution operation. The calculation in the convolution layer is to perform convolution, multiplication and addition operations on the input feature map vector and a convolution kernel, and the result is transformed by the activation function to obtain a new feature map. Such as a 5×5 image, a 3×3 convolution kernel. The convolution kernel has 9 parameters, and then the convolution kernel has 9 neurons, and their output forms a 3×3 matrix. This matrix is called a feature map. The first neuron is connected to the first 3×3 part of the image, and the second neuron is connected to the second 3×3 part.

Compressing the input feature map, on the one hand, makes the feature map smaller and simplifies the computational complexity of the network; on the other hand, performs feature compression to extract main features. In some aspects, such as translation, rotation, and scale, certain characteristics can be kept unchanged. Commonly used are mean-pooling and max-pooling. The input of the pooling layer comes from the convolutional layer. This operation can reduce the amount of data, while retaining valid information and reducing calculation time. For example, if the maximum value is taken for a small block, suppose the window size of pooling is 2×2, if the 4 non-overlapping 2×2 regions are max-pooling respectively.

In the CNN structure, after multiple convolutional layers and pooling layers, one or more fully-linked layers are connected. Each neuron in the fully connected layer is fully connected to all neurons in the previous layer. The fully connected layer can integrate the local information of the convolutional layer or the pooling layer with category discrimination. The core operation of the fully connected layer is the matrix-vector product:

$$a1=W11*x1+W12*x2+W13*x3+b1$$

$$a2=W21*x1+W22*x2+W23*x3+b2$$

$$a3=W31*x1+W32*x2+W33*x3+b3$$

In the process, the algorithm is realized through four steps: reading pictures, randomly assigning samples, network design, training and verification.

5. Conclusion

As the basic research of image recognition algorithms, this paper compares traditional machine learning algorithms, highlights that the image recognition performance of convolutional neural

networks is higher than traditional machine learning algorithms, and shows the superiority of deep learning algorithms. In the future, it is expected that the deep learning image classification algorithm can be deeply studied, and the recognition rate of the network can be further improved.

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