Comparison based on Multiple Machine Learning Algorithms in the Case of Image Classification

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Abstract. With the upsurge of usage of the internet, the society has turned into a Big Data Era. Living in the world overwhelmed with data, the image is among the most common forms. Utilizing these images smartly is the big topic. Image Classification refers to the process of extracting information classes from a raster image that consists of multiple bands by analyzing the raster image. It is the basis for lots of applications, like radar and autopilot. Among tremendous channels for dealing with image, deep learning, Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN), is always the first thing flashing in peoples' mind. In this paper, studies will be implemented and discuss the way to perform image classification utilizing machine learning algorithms. Four algorithms will be implemented, namely Random Forest, KNN, Decision Tree, and Naive Bayes. And at the end of the paper, this result shows that Random Forest Classifier has the best performance compared with the rest of the three algorisms. But it is still far away from the requirement for daily application use like radar. Poor performance and the long operation time make machine learning algorisms out of date when doing image classification. By this comparison, deep learning replaced machine learning and becomes the first choice do this task.

Keywords: Machine Learning; Random Forest; Image Classification.

1. Introduction

With the upsurge of usage of the internet, the society has turned into a Big Data Era. Living in the world overwhelmed with data, people, intentionally or not, generate, send, collect, utilize and analyz a lot of data every day. Among billions of data, the image is the most important form. Through the Internet, these digital objects are created, distributed, altered, and used. Therefore, how to dig out the power behind them is becoming a hot topic given the volume of images flowing across the Internet. Under these significant circumstances, image classification is subsequently born.

Basically, image classification refers to the process of extracting information classes from a raster image that consists of multiple bands by analyzing the raster image. Using the resulting raster that results from the classification of an image, it can be possible to create thematic maps using the resulteing raster. It is important to note that there are two types of classifications, supervised and unsupervised, both of which depend on the way the analyst and the computer interact during the classification process [1-4]. In supervised classification, samples are used in order to determine if images should be classified based on their spectra signatures, in other words, whether they look like training samples. While an unsupervised classification process is one in which spectral classes in multiband images are determined without the analyst having to intervene in the process. Convolutional Neural Network (CNN) is one example of a supervised type of learning, which is applied in many fields [5-7].

As of right now, deep learning is the first concept that comes to mind when discussing image classification. More specifically, one of the most often used tools for image classification jobs is CNN. Does that imply, however, that there isn't another way to categorize images? Undoubtedly, machine learning is another solution. But why it is not always the first choice nowadays? In this paper, studies will be implemented and discuss how to perform image classification based on machine learning algorithms. Four algorithms will be implemented, namely Random Forest Classifier [8], KNN [9], Decision Tree Classifier [10], and Naive Bayes classifier [11]. And at the end of the paper, this study will discuss why deep earning, CNN, is the preferred one for image classification and talk about the future of machine learning shortly.

2. Method

2.1 Dataset and Data Processing

The dataset used in the paper is the CIFAR-10 dataset. CIFAR-10 dataset is well-known public dataset online. These images are often used to train computer vision algorithms and machine learning algorithms in order to improve their accuracy. There is no doubt that this dataset is one of the most commonly used datasets for machine learning research, since it is by far the largest dataset available. There are about 60,000 32x32 color images in a CIFAR-10 dataset, and these images are divided into 10 classes, so that there is a total of 60,000 images in the dataset. The ten classes that we selected have ten different types among them among the ten classes that we selected. Trucks are not only counted among airplanes, cars, birds, cats, deer, dogs, frogs, horses, ships, and trucks, but there are also other kinds of vehicles. There are six different classes of images in total, and there are a total of 6,000 images in total. Figure 1 presents the sample data if the CIFAR-10.

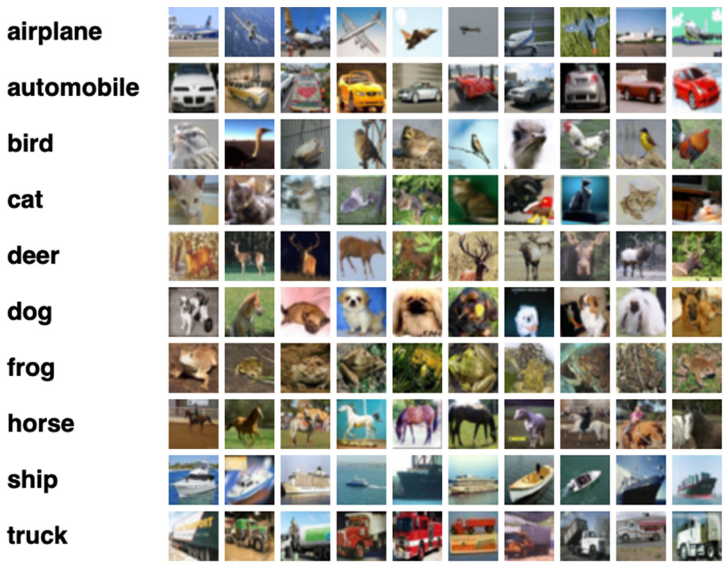

Figure 1. Classes in the dataset and random images for each

In the case of computer algorithms that are designed to identify objects in photos, it is a common trend for them to learn from examples. Using the CIFAR-10 image set, a computer can be taught to recognize objects based on the appearance of the objects by using a set of images that were developed by the project. By comparing the performance of different algorithms on low-resolution images (32x32), researchers can experiment with different algorithms in order to determine which one works best when comparing the results on CIFAR-10's low-resolution images.

Importing TensorFlow, especially Keras, and load the dataset, splitting the dataset into train and test groups. The training process includes obtaining 50,000 images and the testing process involves obtaining 10,000 images. In addition, all of these image's measure 32x32 pixels and are colored. A common step in preprocessing images is normalization, which involves dividing the training dataset by 255.0 for the training dataset and the test dataset by 255.0 for the test dataset as part of the preprocessing step.To ensure that all the images are processed and displayed efficiently, it is important for us to maintain a uniform range of pixels for each image. It is now time to move on to the next most important step of pre-processing, which is applicable only in this case since we are going to make use of machine learning in order to classify images. In order to be able to make use of the machine learning algorithms from Sklearn, the images of the dataset need to be reshaped in a way that allows them to be considered as a two-dimensional array. For the model to be trained using this input shape, the images for the test dataset must also be resized to 2D arrays. This is because the fit() function, which will be used to train the model, expects this as input. It is therefore necessary to resize the images for the test dataset as well so that they can be used during training.

2.2 Implementation – Random Forest Classifier

Combining a number of trees with various classifiers is the basis of the random forest classifier method. Each tree is created by sampling a random vector independently from the input vector, which yields an output reflecting the class that is most frequently used to categorize the input vector (Breiman). This study led to the development of an algorithm known as the random forest classifier, which creates a tree by randomly choosing features at each node or combining various features at each node.

2.3 Implementation – KNN

It is a type of supervised machine learning algorithm that uses the k-nearest neighbors (KNN) algorithm to solve classification and regression problems such as the classification of data based on its neighbors. A data point could be categorized into one group or another according to what group the points around it belong to, and that will determine whether the data point will become part of that group or not. KNN is mainly used for classification problems. Lazy learning is one of the non-parametric algorithms in this algorithm, and it is a lazy learning algorithm. Due to the fact that it doesn't perform any training when training data is provided to it, it is termed a lazy learner. The result of this is that the algorithm only stores the data during the training process and does not make any calculations during this time. It is only after a query has been made to the dataset that a model can be developed from an analysis of the dataset. Therefore, KNN can be ideal for data mining, classification, and other tasks related to data mining.

2.4 Implementation – Decision Tree

Among the various types of decision trees, there are very few that can be used as powerfully as decision trees, which have been used in a wide range of fields, including machine learning, image processing, pattern recognition, and image analysis. With the use of DT, you can efficiently and cohesively compare a series of basic tests using a numeric feature and a threshold value in every test so that a series of tests can be compared efficiently and cohesively. The set of rules that define the way in which nodes are connected to each other in a neural network is easier to construct compared to their numerical weights in a neural network. In the first place, DT was primarily designed for the purpose of grouping things together. The DT model is also a common classification model that is used in data mining to classify samples. A tree is composed of several elements, such as nodes and branches. If a node represents features in a category that needs to be classified, there are several subsets that can define a value that can be accessed by the node, depending on the value that is defined by the subset. Because decision trees can analyze multiple forms of data and are accurate, they have become popular in many fields due to their capability of analyzing multiple forms of data.

2.5 Implementation – Naïve Bayes Classifier

It is possible to use machine learning classifiers to differentiate between different objects on the basis of their characteristics based on certain features of an object that have been identified. It is commonly known that Naive Bayes classifiers are probabilistic models of machine learning that are used in classification systems. The Bayes theorem is at the core of all classifiers, and it can be said that it is their basis. According to Bayes' theorem, when B occurs, we can calculate the probability of A occurring based on the probability of B occurring. The evidence represents B here, while the hypothesis represents A in this example. The assumption here is that the predictors and features must be independent of one another in order to be considered reliable. When there are two features present at the same time, then there is no effect of one on the other when they are both present. This is the reason why it is referred to as naive in the first place. Here are three types of Naive bases classifier: Multinominal naive bayes, Bernoulli naive bayes, and gaussian naive bayes. In this paper, the one used is Gaussian.

3. Result and Discussion

67%, 56%, 27%, and 30% are the final accuracy of the above four different types of machine learning algorithms shown in Figure 2. Random Forest shows the best performance with 67% accuracy followed by KNN with 56% accuracy, NB with 30% accuracy, and Decision Tree with 27% accuracy. Thus, Random Forest exhibits the best performance and Decision Tree the worst.

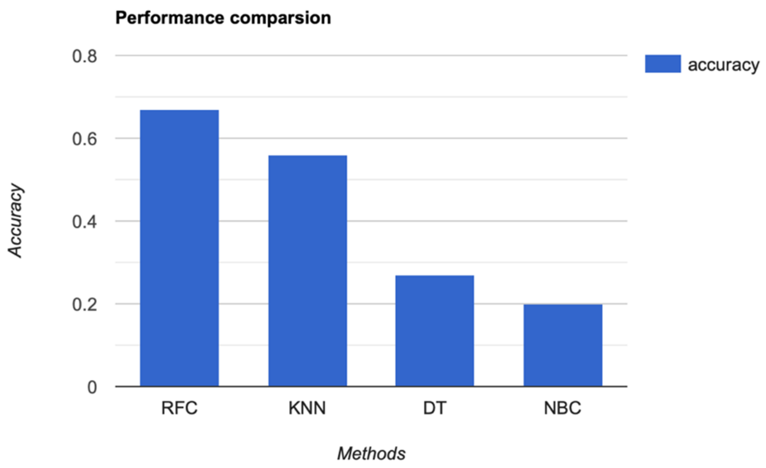

Figure 2. Performance Comparison for four algorisms

4. Discussion

As the bar plot shown in the previous part, the highest accuracy we got here is only 67% by random forest classifier. All machine learning algorithms, however, perform poorly as indicated by their accuracies. Compared to Deep Learning algorithms, which have an accuracy of more than 90%, the highest is only 67%. This accuracy does not mean we cannot use machine learning algorithms to do image classifications. But it is not high enough to perform some real work daily, like radar. High accuracy in image classification is significantly important in the autopilot field. Usable does not mean useful. In this sense, machine learning does have some drawbacks to deep learning. This is the main reason why deep learning dominates the image classification that people mainly use, and it becomes the new heat point in Artificial Intelligence.

5. Conclusion

Machine Learning vs. Deep Learning is a hot topic for a long period of time. There is no exact one that is better than the other. Each one has its own advantages and scenarios and conditions to use. Deep learning as a subset of machine learning, is nowadays, becoming more and more popular. Image classification is the one in that deep learning is quicker and more accurate than machine learning algorisms. The study in this paper implemented four main algorism that can do the classification work. Treating an image as a multidimensional vector and training the model, as usual, the outcome is not desirable, which is way worse than the result gained by deep learning which can generally be almost 99% accurate. This study shows that useable does not imply useful and meaningful. Utilizing and understanding all pros and cons of a tool is the best way to finish the task.

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