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In

Computer Science and Engineering

By

Mohammad Faiz

A7605219061

Under the guidance of

Prof. (Dr.) Syed Wajahat A. Rizvi

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
AMITY SCHOOL OF ENGINEERING AND TECHNOLOGY
AMITY UNIVERSITY UTTAR PRADESH

AMITY UNIVERSITY

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DECLARATION BY THE STUDENT

I, Mohammad Faiz, student of B.Tech hereby declare that the project titled "**Image Classification"** which is submitted by me to Department of Computer Science and Engineering, **Amity School of Engineering and Technology**, Amity University Uttar Pradesh, Lucknow, in partial fulfilment of requirement for the award of the degree of bachelor of technology in Computer Science and Engineering has not been previously formed the basis for the award of any degree, diploma or other similar title or recognition.

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Lucknow
Date: 18-08-2022

Mohammad Faiz
B. Tech (CSE)
A7605219061

AMITY UNIVERSITY

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CERTIFICATE

On the basis of declaration submitted by Mohammad Faiz student of B.Tech (CSE), I hereby certify that the project titled **"Image Classification"** which is submitted to Department of Computer Science and Engineering, **Amity School of Engineering and Technology**, Amity University Uttar Pradesh, Lucknow Campus, in partial fulfilment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering, is an original contribution with existing knowledge and faithful record of work carried out by her under my guidance and supervision.

To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

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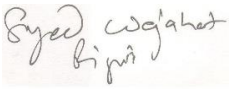
Date: 18-08-2022



Prof. (Dr.) Syed Wajahat A. Rizvi
Professor
Department of Computer Science & Engineering,
Amity School of Engineering and Technology,
Amity University Uttar Pradesh, Lucknow Campus

Abstract:

In this article, we'll go over four well-liked machine learning methods for doing image classification: Random Forest Classifier, KNN, Decision Tree Classifier, and Naive Bayes classifier. We will immediately begin the step-by-step implementation process.

We shall comprehend why Deep Learning is recommended for image classification by the article's conclusion. But if someone wants to compare their CNN image classifier model with some machine learning techniques, the work presented here will be useful for research.

In this we will take a dataset called CIRF 10 And with this help of data set we will check which algorithm is most suitable for image classification. in this we will Traynor data set into 2 categories training data set enter status then we will build our model by using these 4 algorithms of machine learning.

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Sincerely,
Mohammad Faiz
Date: 18-08-2022

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Introduction:

A systematic grouping into categories and subgroups is called classification. Depending on its characteristics. the creation of image categorization reducing the disparity between system and human vision by using the data to teach the computer. The image is classified as obtained by classifying the image into the appropriate group depending on the vision's content. Enthusiasm for this paper comes from. We investigate the use of deep learning in the research of image classification. The traditional techniques for identifying images are part of formally known as an artificial intelligence (AI) component computer learning. The feature extraction component of the machine learning module that pulls out key aspects like edges, text, etc., as well as a classification module that categorises according to the removed. Machine learning's primary drawback is that, while it can only separate out a specific set of attributes from photos and unable to identify distinctive features in the training set of data.

Deep learning is used to address this drawback. Machine learning's subfield of deep learning (DL) is capable of learning using its own computational technique. in-depth learning a model is introduced to continuously dissect data with a homogenous structure similar to how an individual might determinations. Deep learning uses a layered structure to achieve this. A collection of algorithms expressed as an artificial neural network(ANN). Using simulation, the architecture of an ANN is created. The human brain's organic neuronal network. As a result, the Deep learning is more powerful than normal machine learning models. In deep learning, we take into account the neural networks that can depending on its characteristics. This is finished for the structure. developing a comprehensive feature extraction model that can address the challenges posed by traditional approaches. The added-the integrated model's tester should be able to learn how to extract the accurately separating features from the training batch of photos. There are numerous techniques, including GIST, Local SIFT and Binary Patterns are employed to categorise the feature descriptors from the picture,

Data science is an interdisciplinary field that applies information from data across a wide range of application fields by using scientific methods, procedures, algorithms, and systems to extract knowledge and insights from noisy, structured, and unstructured data. Data mining, machine learning, and big data are all connected to data science.

An application of AI called machine learning allows systems to learn from their past performance without having to be explicitly programmed. The goal of machine learning is to create computer programmes that can take data and use it to acquire knowledge on their own.

Machine learning relies on input, such as training data or knowledge graphs, to comprehend things, domains, and the connections between them, much to how the human brain acquires information and understanding. Entities must be defined before deep learning can start.

Dataset:

The CIFAR-10 dataset was utilised in this blog post. Since it is a Keras dataset, you may use a little piece of code to get it right now. It is divided into eleven categories, including truck, ship, automobile, horse, bird, cat, deer, and dog. We will undoubtedly be working on a problem of multi-class classification. This data set will help us to classify the images.

Algorithms Used in Project:

1. Random Forest Classifier.
2. KNN Algorithm.
3. Decision Tree.
4. Naïve Bayes Classifier.

Random Forests Classifier:

What is the Random Forest algorithm?

Popular machine learning algorithm Random Forest is a part of the supervised learning methodology. It can be applied to ML issues involving both classification and regression. It is built on the idea of ensemble learning, which is a method of integrating various classifiers to address difficult issues and enhance model performance.

Random Forest, as the name implies, is a classifier that uses a number of decision trees on different subsets of the provided dataset and averages them to increase the dataset's predictive accuracy.

Instead than depending on a single decision tree, the random forest uses forecasts from each tree and predicts the result based on the votes of the majority of predictions.

First, N decision trees are combined to generate the random forest, and then predictions are made for each tree that was produced in the first phase.

The stages and graphic below can be used to demonstrate the working process:

Step 1: Pick K data points at random from the training set.

Step 2: Construct the decision trees linked to the chosen data points (Subsets).

Step 3: Select N for the size of the decision trees you wish to construct.

Repeat steps 1 and 2 in step 4.

Step 5: Assign new data points to the category that receives the majority of votes by looking up each decision tree's predictions for the new data points.

The following example will help you better understand how the algorithm functions:

Let's use an example where the dataset is made up of several fruit photos. Therefore, the Random forest classifier receives this dataset. Each decision tree is given a portion of the overall dataset. Each decision tree generates a prediction result during the training phase, and the Random Forest classifier predicts the result based on the majority of results when a new data point is encountered.

Machine Learning K-Nearest Neighbor (KNN) Algorithm:

One of the simplest machine learning algorithms, based on the supervised learning method, is K-Nearest Neighbour.

The K-NN algorithm makes the assumption that the new case and the existing cases are comparable, and it places the new instance in the category that is most like the existing categories.

A new data point is classified using the K-NN algorithm based on similarity after all the existing data has been stored. This means that utilising the K-NN method, fresh data can be quickly and accurately sorted into a suitable category.

Although the K-NN approach is most frequently employed for classification problems, it can also be utilised for regression.

Since K-NN is a non-parametric technique, it makes no assumptions about the underlying data.

It is also known as a lazy learner algorithm since it saves the training dataset rather than learning from it immediately. Instead, it uses the dataset to perform an action when classifying data.

The KNN method simply saves the information during the training phase, and when it receives new data, it categorises it into a category that is quite similar to the new data.

Consider the following scenario: We have a photograph of a creature that resembles both cats and dogs, but we are unsure of its identity. Therefore, since the KNN algorithm is based on a similarity metric, we can utilise it for this identification. Our KNN model will look for similarities between the new data set's features and those in the photos of cats and dogs, and based on those similarities, it will classify the new data set as either cat- or dog-related.

Why is a K-NN algorithm necessary?

If there are two categories, Category A and Category B, and we have a new data point, x1, which category does this data point belong in? We require a K-NN algorithm to address this kind of issue. K-NN makes it simple to determine the category or class of a given dataset.

How does K-NN function?

The following algorithm can be used to describe how the K-NN works:

Step 1: Decide on the neighbours' K-numbers.

Calculate the Euclidean distance between K neighbours in step two.

Step 3: Based on the determined Euclidean distance, select the K closest neighbours.

Step 4: Count the number of data points in each category among these k neighbours.

Step 5: Assign the fresh data points to the category where the neighbour count is highest.

Step six: Our model is complete.

Decision Trees:

A tree has many similarities in everyday life, and it turns out that it has affected both classification and regression in a broad range of machine learning. A decision tree can be used in decision analysis to formally and visually reflect decisions and decision-making. It employs a decision-tree-like approach, as the name suggests. Although a common tool in data mining for determining a plan of attack to accomplish a specific objective, it is also widely employed in machine learning, which will be the primary topic of this article.

How can a tree be used to represent an algorithm?

Let's utilise the Titanic data set to forecast whether or not a passenger will survive in order to illustrate this. The data set's three features/attributes/columns, namely sex, age, and sibsp, are used in the model below (number of spouses or children along).

An upside-down decision tree is depicted, with the root at the top.

In the left figure, the bold writing in black denotes an internal node or condition upon which the tree's branches and edges are based. The choice or leaf, in this case, whether the passenger died or lived, is shown as red and green text, respectively, at the end of the branch that doesn't divide any longer.

Although a real dataset will have many more attributes and this will only be one branch of a much larger tree, the simplicity of this technique cannot be overlooked. The significance of the trait is obvious, and relationships are simple to see. This process is more usually referred to as learning decision trees from data, and the tree above is known as a classification tree because the goal is to categorise passengers as having survived or having passed away. The only difference is that regression trees forecast continuous quantities, such as the price of a house. CART, or Classification and Regression Trees, is the common abbreviation for decision tree algorithms.

What exactly is happening in the background, then?

Making choices on which characteristics to employ, what conditions to use for splitting, and when to quit when growing a tree. In order for a tree to look lovely, you will need to trim it down because trees typically grow at random. Let's begin with a standard method for splitting.

Naive Bayes classifier:

A classifier is said to be a machine learning model used to distinguish between various objects according to specific attributes.

Naive Bayes Classifier Principle:

A probabilistic machine learning model called a Naive Bayes classifier is utilised for classification tasks. The Bayes theorem serves as the foundation of the classifier.

Bayes's Theorem:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

The Bayes theorem can be used to calculate the probability that A will occur given the occurrence of B. Here, A is the hypothesis and B is the supporting evidence. Here, it is assumed that the predictors and features are independent. That is, the presence of one characteristic does not change the behaviour of another. The term "naive" is a result.

Example:

	OUTLOOK	TEMPERATURE	HUMIDITY	WINDY	PLAY GOLF
0	Rainy	Hot	High	False	No
1	Rainy	Hot	High	True	No
2	Overcast	Hot	High	False	Yes
3	Sunny	Mild	High	False	Yes
4	Sunny	Cool	Normal	False	Yes
5	Sunny	Cool	Normal	True	No
6	Overcast	Cool	Normal	True	Yes
7	Rainy	Mild	High	False	No
8	Rainy	Cool	Normal	False	Yes
9	Sunny	Mild	Normal	False	Yes
10	Rainy	Mild	Normal	True	Yes
11	Overcast	Mild	High	True	Yes
12	Overcast	Hot	Normal	False	Yes
13	Sunny	Mild	High	True	No

Let's use an illustration to gain a better understanding. Think about the issue of playing golf. The dataset is displayed as follows.

Based on the characteristics of the day, we determine if it is appropriate to play golf. These features are represented by columns, whereas individual items are represented by rows. If we look at the first row of the dataset, we can see that it is not recommended to play golf when it is raining, hot outside, humid, and not windy. As mentioned before, one of our two presumptions is that these predictors are independent. In other words, just because it's hot outside doesn't necessarily mean that it's humid. Another supposition made here is that the influence of each predictor on the result is equal. In other words, whether or not to play golf on a windy day is not more important.

This example shows how to rewrite the Bayes theorem as:

$$P(y|X) = \frac{P(X|y)P(y)}{P(X)}$$

The class variable (play golf) in the variable y indicates whether the conditions are acceptable for playing golf or not. The parameters/features are represented by variable X.

X appears as,

$$X = (x_1, x_2, x_3, ..., x_n)$$

Here, the features are represented by the numbers x 1, x 2,.. x n, which can be translated to outlook, temperature, humidity, and windy. By replacing X and expanding using the chain rule, we obtain,

$$P(y|x_1, ..., x_n) = \frac{P(x_1|y)P(x_2|y)...P(x_n|y)P(y)}{P(x_1)P(x_2)...P(x_n)}$$

Now you may look at the dataset to get the values for each and then enter them into the equation. The denominator does not change for any of the entries in the dataset; it remains constant. As a result, the denominator may be eliminated and proportionality may be added.

$$P(y|x_1, ..., x_n) \propto P(y) \prod_{i=1}^{n} P(x_i|y)$$

The class variable (y) in our example only has two possibilities: yes or no. There may be circumstances in which the classification is multivariate. As a result, we must identify the class y with the highest probability.

We may get the class given the predictors by using the aforementioned function.

$$y = argmax_y P(y) \prod_{i=1}^{n} P(x_i|y)$$

Practical Implementation:

First, let's import the required packages like tensorflow, matplotlib, numpy, accuracy score, confusion matrix, classification report. And we will also import cv2.

then we will load the data that is CIFAR10 data set.

Further, we can obtain the size of the train and test datasets.

Thus, there is a total of 50,000 images for training and 10,000 images for testing. Besides, each of these images is of dimensions 32×32 and colour. The above details can be easily inferred from the shape returned.

Normalization is a common step of image pre-processing and is achieved by simply dividing x_train by 255.0 for the train dataset and x_test by 255.0 for the test dataset. This is essential to maintain the pixels of all the images within a uniform range.

then we will reshapes train set images from (50000,32,32,3) which is a 4D array to (50000,3072), a 2D array.3072 is obtained by multiplying the dimensions of the image(32x32x3=3072).
Similarly, the images of the test set are reshaped from (10000,32,32,3) to (10000,3072).

then we will implement a random forest classifier for this we have to import it from sklearn library.

then we will create an instance of the RandomForestClassifier class. Finally, let us proceed to train the model. after training our model now, we will predict for the test set using the fitted Random Forest Classifier model.

This prediction will give us numbers from 0 to 9 as the output. Then, We will evaluate the model with the test images by obtaining its classification report, confusion matrix, and accuracy score.

It is implemented in sklearn using KNeighborsClassifier class. We begin by importing it and then instantiating it to create a KNN model After importing and instantiating we will train our data set.

Now, We will predict for the test set using the fitted KNN model.

After this we will evaluate the model with the test images by obtaining its classification report, confusion matrix, and accuracy score.

Implementati of sklearn using the DecisionTreeClassifier class. We begin by importing it and then instantiating it to create a DecisionTreeClassifier model After all doing this we will train it.

Now, predict for the test set using the fitted decision tree model. And thenevaluate the model with the test images by obtaining its classification report, confusion matrix, and accuracy score.

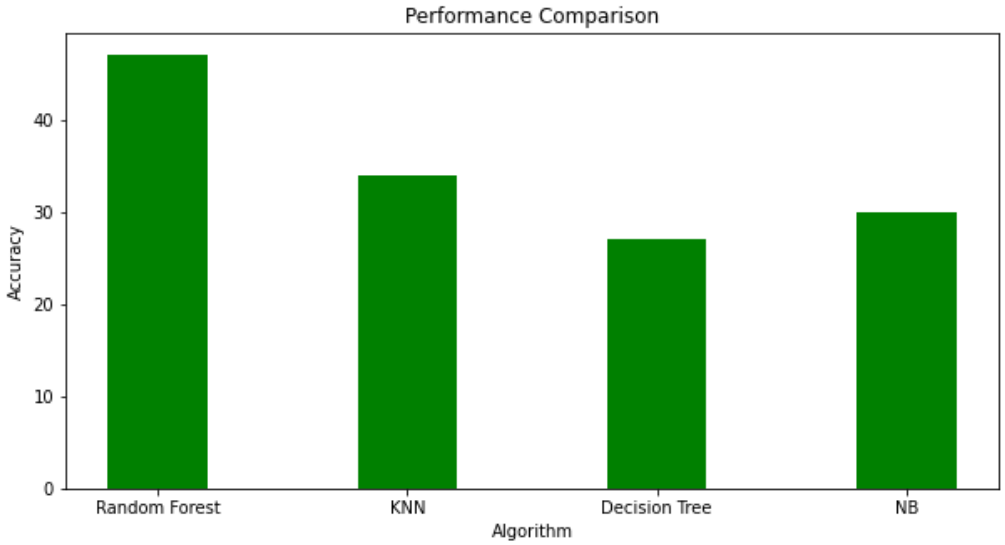
Implementing a Naïve Bayes classifier We begin by importing it. We will import GaussianNB from sklearn

Then instantiating it to create an NB model. After importing and instantiating we will train it

Now, we will predict for the test set using the fitted NB model.

Evaluate the decision tree model just the way we evaluated our previous model.

Results:



The graph above can be used to summarise the accuracies of the four ML algorithms we recently investigated for our CIFAR-10 dataset.

In this graph we have compared all 4 algorithms which are random forest, knn, decision tree and NB.

By comparing this we can say that random forest has given the most accurate answer.

The Random Forest Classifier performs the best, with an accuracy rate of 47%, followed by the KNN, with 34%, the NB, with 30%, and the Decision Tree, with 27%. As a result, Decision Tree performs poorly whereas Random Forest performs best.

However, as shown by the accuracies, all machine learning methods perform poorly. The highest is only 47% but Deep learning algorithms outsmart them remarkably with accuracies that are typically more than 90%!!!

Because of this, I explicitly stated at the outset that this work can only be used to contrast and support a Deep Learning model.

Inspecting custom input:

We will select this model based on the results above because it offers the best performance and a respectable level of accuracy.

A single image that you want to send to the model and test is referred to as a custom input. In many real-time applications, testing a model for a single input is common practise. For instance, the system receives a snapshot of a person for face recognition.

To test my model, I utilised the customised image.

Conclusion:

So, using four popular ML algorithms—Random Forest, KNN, Decision Tree, and Naive Bayes classifier—we described how to apply image classification in machine learning in this blog. Deep learning is preferred for picture classification problems due to their poor accuracies.

By attempting to enhance these picture categorization in ML models via hyperparameter tuning, you can investigate this work in more detail. If so, you might achieve more accuracy! Try it anyway!

Reference:

https://www.1stop.ai/projects

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