Report on Image Classification Using CIFAR-10 Dataset with K-Nearest Neighbors Classifier

(https://github.com/arnabishakh/ML_Spring_23_24/tree/25fb6ded5fcb2b67da798e240ec66f7ff4d799d3/Mid)

Introduction:

The CIFAR-10 dataset was used for an image classification work, and the k-nearest neighbours (k-NN) algorithm was used. The results of this task are presented in this article. The aim was to construct an image classification model by utilising Euclidean (L2) distances and utilising 5-fold cross-validation to determine the ideal value of k.

Dataset Description:

The CIFAR-10 dataset consists of 60,000 32x32x3 color images categorized into 10 different classes. There are 10,000 photographs in the testing set and 50,000 images in the training set. Owing to memory limitations, only a portion of the testing and training data was used for categorization.

Model Building and Evaluation:

The grayscale CIFAR-10 images were classified using the k-nearest neighbours technique. An image is classified by the algorithm taking into account the class labels of its k closest neighbours. Using the Euclidean (L2) distance metric, the similarity between the photos was calculated. The ideal value of k was ascertained by evaluating the model with 5-fold cross-validation. The training dataset was split up into five subsets, or folds, and the model was trained and assessed five times, using various combinations of training and validation data, for every value of k.

Results and Analysis:

The following results were obtained:

Model Accuracy L2:

The average accuracies across all folds for various values of k were computed as follows:

- ⇒ k = 1: 28.13%
- ⇒ k = 3: 27.46%
- ⇒ k = 5: 28.59%
- ⇒ k = 8: 28.77%
- ⇒ k = 10: 28.49%
- ⇒ k = 12: 28.48%
- ⇒ k = 15: 28.32%
- ⇒ k = 20: 28.58%
- ⇒ k = 50: 27.29%
- ⇒ k = 100: 26.19%

With k=5, the model achieved an accuracy of 29.6% on the testing data.

For L1,

- ⇒ k = 1: 32.00%
- ⇒ k = 3: 31.55%
- ⇒ k = 5: 32.45%
- ⇒ k = 8: 32.40%
- ⇒ k = 10: 32.95%
- ⇒ k = 12: 32.70%
- ⇒ k = 15: 32.35%
- ⇒ k = 20: 31.90%
- ⇒ k = 50: 30.50%
- ⇒ k = 100: 30.45%

Discussion:

When we compare the outcomes using the Euclidean distance and Manhattan (L1) distance, we find that the best k value chosen for the classifiers and average accuracy differ.

The best k value for the Manhattan distance (L1) was 8, which resulted in an accuracy of 0.2877. The average accuracy for the Manhattan distance (L1) varied between roughly 0.2619 and 0.2877. In contrast, the Euclidean distance accuracy ranged from roughly 0.2619 to 0.2859 on average, with 8 being the best k value and yielding an accuracy of 0.2877.

Both distance measures yielded average accuracies that were comparable overall, with the Manhattan distance slightly beating the Euclidean distance for some values of k. For both criteria, however, the best k value and its accuracy were the same. Thus, in this particular case, the model's performance was not greatly affected by the distance measure selection.

Conclusion:

In summary, the CIFAR-10 dataset was used to classify images using the k-nearest neighbours algorithm. The ideal value of k was found via cross-validation, and it turned out to be 8. Although k-NN offered a respectable classification method, more advanced models such as NN or CNN might be able to achieve better accuracy on this dataset.