Analytathon 2 Report

Introduction

Bird songs are an essential component of the natural environment and can be used to track the various bird species in a given area. Experts find it challenging to distinguish between different bird species simply by listening to these recordings. With advancements in technology, the classification and clustering of bird songs have become an increasingly popular method to assist in resolving this issue (John 2023, p.3).

In this report, we will focus on the use of Convolutional Neural Networks(CNN) in bird song recognition and how they manage to achieve such high levels of accuracy. Following that, the performance of using k-means clustering to divide the bird song clips into clusters will next be evaluated.

Methodology

Classification – Convolutional Neural Network

To classify the bird audio clips, we choose CNN as our model. The benefit of this model is that it will combine information from input features that are spatially correlated with each other, because usually the pixels that are closer together are more likely to be similar to each other, which will lead to a better result while handling picture inputs than other supervised learning models (David 2023, p.61).

We feed the spectrograms of bird songs into the CNN model in order to train it to be able to learn the unique features of different bird songs and classify them accordingly. Spectrograms are plots that could show sound waves visually. All of the spectrograms were imported, converted to pixels, and then the data was filtered and labelled with the corresponding species to prepare it for the next stage. Next, the dataset is split into training and testing sets, with the test set accounting for 20% and this ratio of 80/20 is the optimal ratio after several attempts.

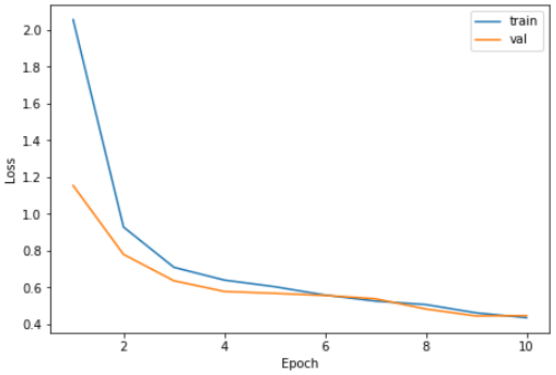
Finally, we move on to model construction. The following layers are used in this model. The convolutional layer is applied to extract the relevant features. The MaxPooling layer lower the spatial dimension to help reduce overfitting. The ReLU activation layer decreases the linearity of the model. The dropout layer randomly drops out 40% of neurons to prevent overfitting as well. The Flatten layer converts the output into a 1D array. And the fully connected layer performs the classification by mapping the input to the output.

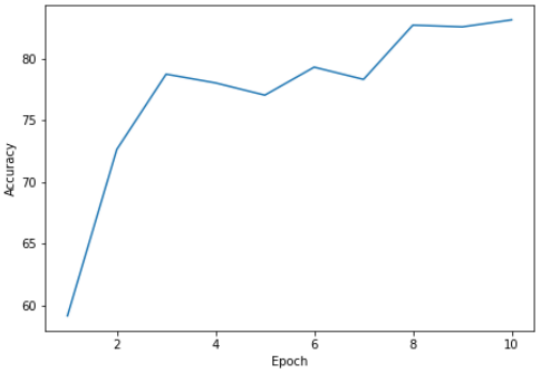
Clustering – K-means Clustering

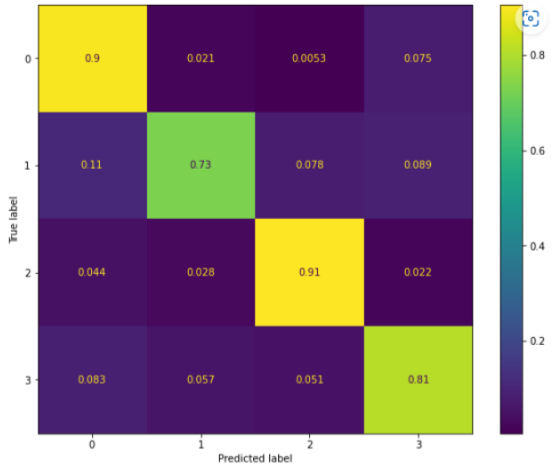
To group birds into clusters, we use k-means clustering and Principal Component Analysis(PCA) to help. We first applied k-means to find the optimum number of clusters. We then applied PCA to help reduce the number of variables, as we had a total of 137 columns. Next, before and after applying PCA, the results of k-means were plotted as scatter plots and the difference between these two plots was the outliers. Finally, we wanted to find the purity of each cluster by extracting the number of different birds in each cluster and dividing it by the total number of data in that cluster.

Conclusion

Classification – Convolutional Neural Network

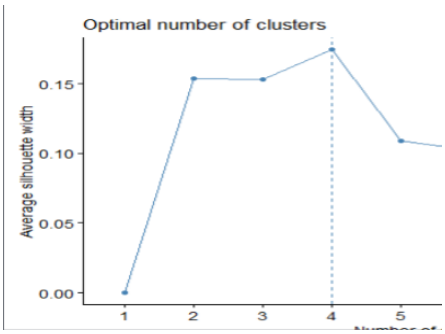






After 10 epochs of training, our loss decreased to 0.435 and our accuracy reached 83.1%, which is a pretty satisfactory result. And with the help of confusion matrix, we can determine the accuracy of each bird. Birds 0 and 2 have really good accuracy and they are both above 90%. The other two bird species have relatively low accuracy, and this is the major limitation of this model. We guess this is caused by the noisy data in the spectrograms. A greater focus on building a model that could deal with the noise and classify birds 1 and 3 could produce interesting findings that have better accuracy overall.

Clustering – K-means Clustering



From the k-means clustering plot, we found that splitting our data into 4 clusters was the best solution in the above figure. As we have 4 different bird species in our data, the results here are quite reasonable. By comparing the plots before and after applying PCA, 2313 outlier points were found. In terms of purity, stock dove clustered better than other three species, as stock dove accounted for 88.61% of the 3rd cluster.

Reference

1. John P, 2023, *Bird Song Recognition*, lecture notes, DSA8023 Analytics in Action, Queen's University Belfast,delivered 20 Apr 2023
2. Dr. David W, 2023, *Lecture 3: Convolutional Neural Networks*, lecture notes, DSA8021 Machine Learning, Queen's University Belfast, delivered 30 Jan 2023