project report

Ruth Tamiru

June 2024

1 Introduction

The rapid advancement in image processing and machine learning techniques has made it possible to accurately classify objects within images. One such application is the identification of bird species from images. This report details the creation of a Convolutional Neural Network (CNN) designed to predict bird species. Utilizing different layers and hyperparameters, the project aims to build, train, and test a multiclass classification model.

2 Problem statement

Identifying bird species manually from images can be time-consuming and prone to errors, especially when dealing with a large dataset. The goal of this project is to automate the classification of bird species from images using a CNN, improving accuracy and efficiency in ornithological studies and wildlife monitoring.

3 Methodology

The methodology involves several key steps:

1. **Data Collection and Preparation**: Collecting images of various bird species, preprocessing them, and dividing them into training, validation, and testing sets.
2. **Model Building**: Designing a CNN architecture suitable for image classification tasks.
3. **Training and Evaluation**: Training the model on the prepared dataset, evaluating its performance, and fine-tuning hyperparameters.
4. **Prediction and Visualization**: Using the trained model to predict bird species from new images and visualizing the results.

4 Proposed solution

A Convolutional Neural Network (CNN) is proposed due to its effectiveness in image recognition tasks. The CNN will consist of multiple layers, including convolutional layers, pooling layers, a flattening layer, and dense layers, optimized for classifying bird species.

5 System Architecture

The system architecture comprises the following components:

1. **Input Layer**: Takes images of bird species as input.
2. **Convolutional Layers**: Apply convolution operations to extract features from the images.
3. **Pooling Layers**: Reduce the spatial dimensions of the feature maps.
4. **Flatten Layer**: Converts the 2D feature maps into a 1D feature vector.
5. **Dense Layers**: Perform classification based on the extracted features.
6. **Output Layer**: Outputs the probabilities for each bird species class.

6 Implementation details

The implementation involves several steps:

1. **Library Imports**: Necessary libraries such as NumPy, pandas, Matplotlib, OpenCV, Keras, and Scikit-learn are imported.
2. **Data Loading and Preprocessing**:
   - Images are read from the dataset directory.
   - Images are converted to numpy arrays and stored in lists along with their corresponding labels.
   - The dataset is split into training, validation, and testing sets.
   - Images are normalized and reshaped for input into the CNN.
   - Labels are binarized using LabelBinarizer.
3. **Model Building**:
   - A Sequential model is created.
   - Convolutional and pooling layers are added.
   - The model is compiled with categorical cross-entropy loss, Adam optimizer, and accuracy metrics.

4. **Model Training**:
    - The model is trained for 50 epochs with a batch size of 128.
    - Training and validation accuracy and loss are monitored.
5. **Evaluation**:
    - The model is evaluated on the test set to determine its accuracy.
    - Predictions are stored and compared with true labels.
6. **Visualization**:
    - Training and validation accuracy and loss are plotted.
    - A confusion matrix is generated to visualize classification performance.

7 Results

The trained model achieved a high accuracy on both the training and validation sets. The test accuracy further confirmed the model's effectiveness in classifying bird species. Visualization of training history and confusion matrix provided insights into model performance and areas for potential improvement.

8 Deployment

The model can be deployed as a web application or integrated into existing wildlife monitoring systems. The deployment involves setting up a server to handle image uploads, processing the images through the trained model, and displaying the predicted bird species to the user.

9 Conclusion

The project successfully demonstrates the use of Convolutional Neural Networks for bird species classification. The model achieved high accuracy and can significantly aid in automating ornithological studies. Future work could involve expanding the dataset, refining the model architecture, and exploring transfer learning techniques for further improvements.