Artificial Intelligence & Machine Learning

Project Report

Semester-IV (Batch-2022)

Bird species identification from their name

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1. ABSTRACT

This project dives machine learning methodologies in the realm of bird image classification, with a particular emphasis on their implications for conservation efforts and educational initiatives. Through the utilization of a comprehensive dataset containing images representing approximately 500 distinct bird species, the primary objective is to develop robust classification models capable of accurately identifying avian species from visual data.

Methodological approaches encompass the entire spectrum of model development, from meticulous data curation and preprocessing techniques to the implementation of sophisticated convolutional neural networks (CNNs) for training and inference. By leveraging these state-of-the-art techniques, the project endeavors to address a wide array of applications spanning from species identification and conservation monitoring to the enhancement of eco-tourism experiences and educational resources, thereby serving as a valuable tool for both researchers and enthusiasts alike.

Furthermore, the project underscores the broader implications of AI and machine learning technologies in fostering a deeper understanding of avian biodiversity and promoting public engagement in conservation endeavors. Additionally, the integration of multi-modal learning approaches, incorporating diverse data modalities such as images, audio recordings of bird calls, and textual descriptions, holds promise for the development of more comprehensive classification models with enhanced interpretability and robustness.

In its culmination, the project's deployment of a user-friendly website for bird species classification represents a significant milestone in democratizing access to bird identification tools, thereby empowering conservationists, educators, and citizen scientists with the means to contribute meaningfully to avian biodiversity preservation and educational outreach efforts.

2. INTRODUCTION

In an era marked by rapid technological advancements, the intersection of artificial intelligence (AI) and machine learning has emerged as a powerful tool in the realm of biodiversity conservation and environmental education. Among the myriad applications of these technologies, the classification of bird species from images stands out as a particularly promising avenue for both researchers and enthusiasts.

With the availability of vast datasets comprising images representing hundreds of bird species, there exists an unprecedented opportunity to leverage AI and machine learning methodologies to develop robust classification models. These models hold the potential to revolutionize our understanding of avian biodiversity, offering insights into species distribution, behaviour patterns, and ecological interactions.

Beyond their conservation implications, bird image classification models also hold significant promise for educational purposes. By providing accessible and engaging platforms for bird identification, these models empower enthusiasts of all ages to deepen their appreciation for avian diversity and actively participate in citizen science initiatives.

In light of these considerations, this project embarks on a journey to explore the multifaceted applications of AI and machine learning in bird image classification. Through meticulous data curation, innovative model development, and strategic deployment of classification tools, the project endeavors to unlock new avenues for conservation, education, and public engagement.

2.1 Background

The Accurate bird species identification is vital for conservation and education. Traditional methods, reliant on manual observation, are time-consuming and prone to error. In contrast, AI techniques like convolutional neural networks (CNNs) show remarkable accuracy in classifying bird species from images. Challenges persist, including scalability with large datasets and ensuring accuracy across diverse environmental conditions. This project utilizes the Kaggle dataset "100 Bird Species" by gpiosenka to develop a robust classification model. By leveraging CNNs, the project aims to create user-friendly tools for bird identification, benefiting conservation, education, and scientific research globally.

2.2 Objective

The objective of this project is to develop a robust classification model for accurately identifying bird species from images, leveraging AI and machine learning techniques. Key objectives include developing and training a convolutional neural network (CNN) model .Additionally, data pre-processing techniques such as image normalization, augmentation, and standardization will be implemented to enhance model performance. A user-friendly website or platform will be created to allow users to easily upload bird images for identification. Intuitive user interface elements and interactive features will be incorporated to enhance user experience and facilitate seamless image classification.

2.3 Significance.

- By leveraging AI and machine learning techniques, the project aims to overcome the limitations of traditional methods, which are often time-consuming, subjective, and reliant on expert knowledge.
- Accurate bird species identification is essential for effective conservation management, as it enables researchers and conservationists to monitor and protect avian biodiversity more efficiently.
- The project's user-friendly website has the potential to democratize bird identification, empowering citizen scientists, educators, and enthusiasts to contribute to conservation efforts and biodiversity monitoring.
- In the realm of education, the project serves as a valuable resource for fostering a deeper understanding and appreciation of avian biodiversity. By providing accessible tools for bird identification, the project facilitates hands-on learning experiences for students and educators alike.

3. PROBLEM DEFINITION AND REQUIREMENTS

3.1 Problem Statement

The project aims to tackle the challenge of accurate bird species identification by leveraging AI and machine learning techniques. Traditional methods for identifying bird species are often labour-intensive and require specialized knowledge, limiting their accessibility and scalability. By developing a robust classification model and user-friendly platform, the project seeks to streamline the process of bird identification, empowering conservationists, researchers, educators, and enthusiasts to contribute to biodiversity monitoring and conservation efforts more effectively. Through this endeavor, the project endeavors to bridge the gap between scientific research and public engagement in avian biodiversity conservation and education.

3.2 Software Requirements

- Programming Language: Python was utilized throughout the project, leveraging its extensive libraries and frameworks tailored for data analysis and machine learning tasks.
- Integrated Development Environment (IDE): The project workflow involved using Google Colab for creating and training machine learning models due to its cloud-based infrastructure and built-in support for Python and TensorFlow. PyCharm was employed for developing the Streamlit web application, offering efficient coding capabilities and seamless integration with Python projects.
- Libraries and Packages: Essential libraries such as NumPy, pandas, scikit-learn, and TensorFlow were installed for data manipulation, analysis, and machine learning tasks.
- Data Visualization libraries like matplotlib, seaborn, cv2, and skimage were utilized for visualization and image processing tasks, enhancing the interpretability and effectiveness of the classification models. The project's reliance on these libraries underscores Python's versatility and robust ecosystem for data-driven projects. gplot2 and ggvis, are commonly used for data visualization.

3.3 Hardware Requirements

- Processor (CPU): A multicore processor with sufficient computational power is essential for training machine learning models efficiently. A modern CPU with multiple cores, such as Intel Core i5 or i7, or AMD Ryzen processors, is recommended.
- Memory (RAM): Sufficient RAM is crucial for handling large datasets and performing complex computations. At least 16 GB of RAM is recommended for large-sized datasets.
- Storage (Hard Drive or SSD): Adequate storage space is necessary for storing datasets, software, and model files. A solid-state drive (SSD) is preferable for faster data access and model training compared to traditional hard disk drives (HDD).
- Graphics Processing Unit (GPU): While not mandatory, using a GPU can significantly accelerate the training of deep learning models, especially for tasks involving large-scale data processing and complex neural networks. NVIDIA GPUs, such as GeForce GTX or RTX series, are commonly used for machine learning tasks.

3.4 Data Sets

The dataset consists of 525 bird species, with 84635 training images, 2625 test images, and 2625 validation images. All images are of high quality, with each containing only one bird occupying at least 50% of the pixels. The images are in 224x224x3 jpg format.. The dataset includes a CSV file containing file paths, labels, scientific names, and dataset indicators. Hand-selected test and validation images ensure high accuracy scores, though model performance may vary on unseen images, particularly those of female species due to the dataset's male-biased ratio.

4. Proposed Design / Methodology

4.1 Schematic Diagram

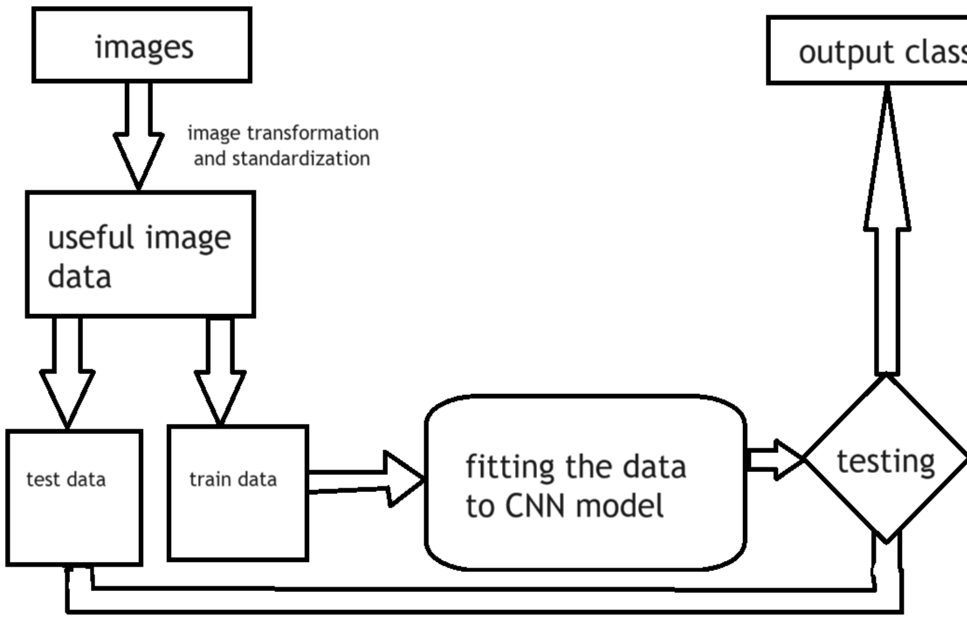

Fig1.Full Machine learning process

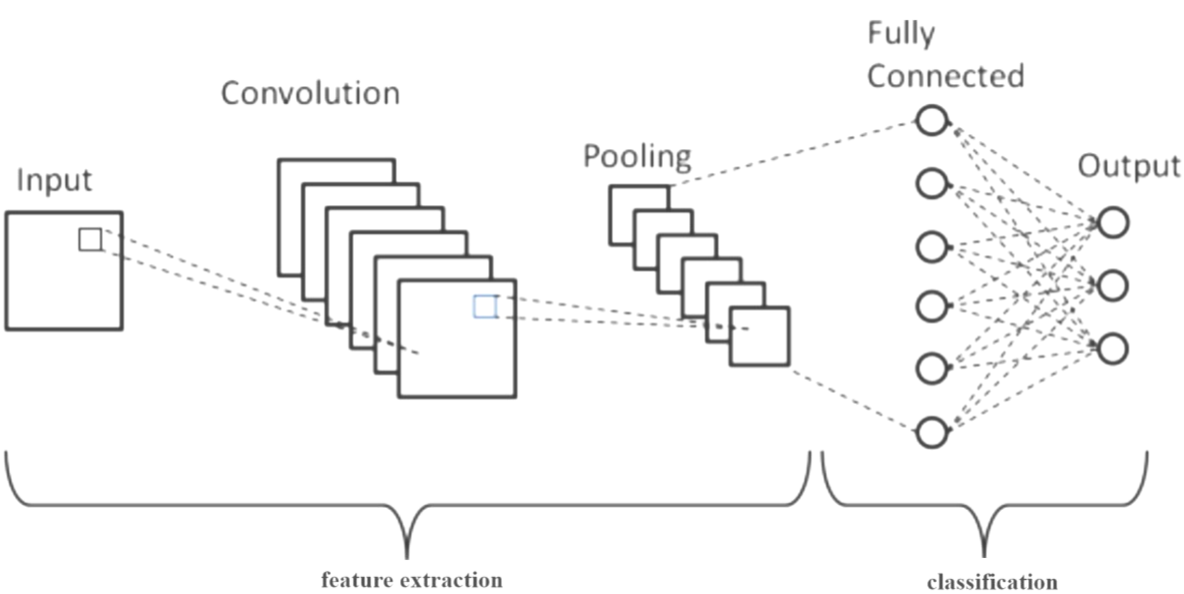

Fig2.A CNN model schematic diagram

4.2 File Structure

The project structure comprises an IPython Notebook for model training, where the trained model is saved as "my_model.h5". Additionally, within the project directory named "birdClassification," a separate Python file named "Dashboard.py" has been created to develop the application. This architecture segregates the model development process from the application implementation, ensuring modularity and ease of maintenance. The "birdClassification" directory serves as the central location for all project-related files, facilitating organization and collaboration. By adopting this structured approach, the project can be efficiently managed and extended, with clear separation of concerns between model development and application deployment.

4.3 Algorithm

Convolutional Neural Networks (CNNs) are a class of deep learning models specifically designed for processing grid-like data, such as images. They consist of multiple layers, including convolutional, pooling, and fully connected layers, each performing specific operations to extract and learn hierarchical features from input images.

CNNs leverage convolutional operations to systematically apply filters across input images, capturing spatial patterns and features at different scales. Pooling layers further reduce spatial dimensions, enhancing computational efficiency and promoting translation invariance. With their ability to automatically learn intricate features from raw pixel data, CNNs have become the cornerstone of modern computer vision tasks, achieving remarkable performance in image classification, object detection, and image segmentation tasks.

Their hierarchical architecture and weight sharing properties make them particularly effective for extracting complex patterns and representations from large-scale datasets, revolutionizing the field of deep learning and advancing the state-of-the-art in various image-related applications.

5. **Results**

The model showed accuracy of 0.94.About 94 images of 100 were classified correctly.

	precision	recall	f1-score	support
0	1.00	1.00	1.00	10
1	1.00	0.90	0.95	10
2	0.83	1.00	0.91	10
3	0.91	1.00	0.95	10
4	1.00	1.00	1.00	10
5	0.90	0.90	0.90	10
6	1.00	0.70	0.82	10
7	1.00	1.00	1.00	10
8	0.82	0.90	0.86	10
9	1.00	1.00	1.00	10
accuracy			0.94	100
macro avg	0.95	0.94	0.94	100
weighted avg	0.95	0.94	0.94	100

Fig-2.1 precision, recall, f1-score and accuracy for different categories of birds

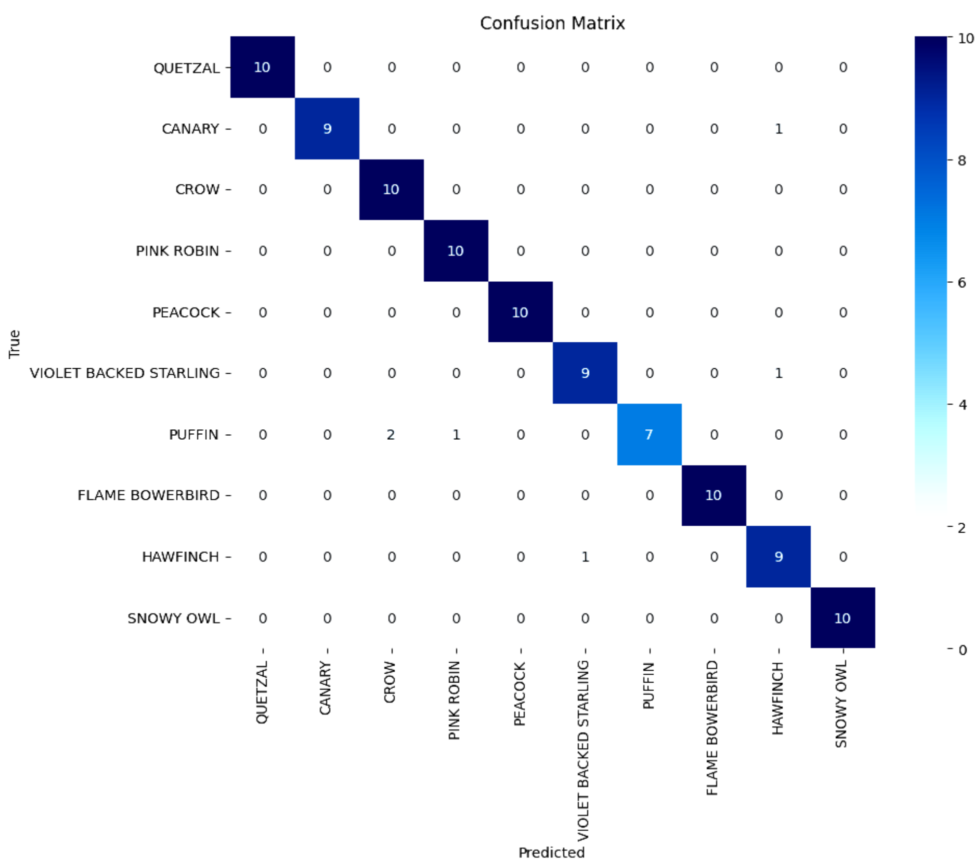

Fig2.2 Test result Confusion matrix

5.1 Screenshots