**PROJECT ABSTRACT**

# Bird Species Classification using EfficientNet

*EfficientNet classifier that identifies bird species from user-uploaded photos, delivered as a built-to-order student project with code, trained weights, report, PPT and viva kit.*

## 01. Title

Bird Species Classification using EfficientNet

## 02. Introduction / Background

Identifying birds by sight is a classic fine-grained recognition problem: species differ only in subtle cues such as beak shape, wing bars or posture, and field guides take years to master. Deep learning changed this — convolutional networks trained on large annotated sets can now separate hundreds of near-identical species. The CUB-200-2011 dataset (11,788 photographs across 200 North American bird species) is the standard academic benchmark for the task. This project fine-tunes an EfficientNet-B0 classifier on CUB-200-2011 via ImageNet transfer learning and serves it through a Flask demo application.

## 03. Problem Statement

Beginners, students and citizen scientists lack an accessible tool that identifies bird species from a photograph and explains its confidence. The project addresses this by building a 200-class image classifier with a clean upload-and-predict demo interface, top-5 ranked predictions, and a training experiment whose metrics are fully logged and auditable — suitable both as a learning tool and as a complete final-year project.

## 04. Objectives

- Fine-tune EfficientNet-B0 (ImageNet transfer learning, gradual unfreezing) on CUB-200-2011 for 200-class species classification.
- Reach a design target of ~75-80% top-1 accuracy on the held-out split, with the training notebook logging top-1/top-5 accuracy, loss curves and the confusion matrix during the build.
- Build a Flask demo app with drag-and-drop upload, top-5 ranked predictions with confidence bars, and species fact cards.
- Deliver the complete student kit: source code, trained .pth weights, report, PPT and viva Q&A document.

## 05. Proposed System / Working

The system has three stages. (1) Data pipeline: CUB-200-2011 images are split into train / validation / held-out splits with stratified sampling, and training images are augmented with random crops, horizontal flips and color jitter. (2) Model: EfficientNet-B0 pre-trained on ImageNet has its classifier head replaced with a 200-way output; the head is trained first, then deeper blocks are gradually unfrozen at a lower learning rate. Every epoch logs top-1/top-5 accuracy and loss curves. (3) Demo application: a Flask app resizes each upload to 224x224, runs inference, and displays the top-5 species with confidence bars alongside the predicted bird's fact card.

## 06. Technologies / Components Used

- Python 3.10, PyTorch with timm EfficientNet-B0
- Torchvision (transforms, DataLoaders)
- NumPy, scikit-learn (metrics, confusion matrix)
- Matplotlib, Seaborn (accuracy curves, per-class analysis)
- Flask demo web app with image-upload UI
- CUB-200-2011 dataset (11,788 images, 200 species)
- Trained weights shipped as .pth

## 07. Key Features

- 200-class bird species classification from a single uploaded photo
- Top-1 and top-5 predictions with confidence scores
- Data augmentation pipeline (crops, flips, color jitter)
- Training notebook logging accuracy/loss curves and confusion matrix
- Prediction visualization: top-5 species ranked with confidence bars
- Species fact cards (common name, scientific name)
- Train/validation/test split with per-class accuracy report

## 08. Applications / Use Cases

- Birdwatching assistance for beginners and citizen-science projects
- Educational tool for ecology and biology coursework
- Reference build for other fine-grained classification tasks (plants, insects, dog breeds)
- Teaching material for transfer learning, augmentation and top-k metrics

## 09. Results & Scope

The deliverable is a design-target-driven build, not a pre-measured product. The training notebook computes top-1 and top-5 accuracy on the held-out split every epoch and logs loss curves and a confusion matrix; the report presents these as the build's measured results. The design target is ~75-80% top-1 accuracy. Scope is classification of the 200 CUB-200-2011 species from still photographs — it does not identify species

outside this set, does not use audio (birdsong), and is an educational prototype rather than a substitute for expert ornithological identification.

## 10. Conclusion

Bird Species Classification using EfficientNet delivers a complete fine-grained classification project: a real-world recognition problem, the standard CUB-200-2011 benchmark, an EfficientNet-B0 model fine-tuned through a fully logged transfer-learning experiment, and a demo app that makes the result visible in seconds. The per-class error analysis — which sparrows get confused with which — gives the student rich, honest material for the report and viva.

## 11. References


- Welinder, P. et al. — Caltech-UCSD Birds-200-2011 (CUB-200-2011), Technical Report CNS-TR-2011-001, California Institute of Technology, 2011.
- Tan, M. and Le, Q. V. — EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks (arXiv:1905.11946).
- Wah, C. et al. — The Caltech-UCSD Birds-200-2011 Dataset (project page, vision.caltech.edu).
- PyTorch and timm documentation (pytorch.org; timm model library) — training and transfer-learning tooling used in the build.