**Capstone Project: Automated Wildlife Image Classification Using Transfer Learning**

**1. Introduction**

**1.1 Project Overview**

EcoTrack Conservation Initiative aims to automate the classification of wildlife species using the iNaturalist dataset. The organization collects thousands of images from citizen scientists and researchers, but manual classification is time-consuming and inefficient. This project leverages transfer learning with a model to automate species identification, aiming for at least 60 percent accuracy initially.

**1.2 Problem Statement**

Manual classification of wildlife images is labor-intensive and error-prone. Automating this process will enhance biodiversity research, conservation efforts, and ecological monitoring.

**2. Methodology**

**2.1 Data Collection & Preprocessing**

* **Dataset:** iNaturalist dataset (12K images of various species)
* **Preprocessing:** Resizing to 224x224 pixels, normalization, and data augmentation (rotation, flipping, zooming)
* **Train-Test Split:** 90% training, 10% validation

**2.2 Model Selection & Training**

* **Base Model:** ResNet50 (pretrained on ImageNet)
* **Custom Layers:** Fully connected layers with ReLU activation, dropout (0.5), and softmax output
* **Optimization:** Adam optimizer, learning rate = 0.0001
* **Loss Function:** Categorical Crossentropy
* **Early Stopping:** Patience of 3 epochs

**2.3 Hyperparameter Tuning**

To optimize performance, we tuned several hyperparameters:

* **Learning Rate:** 0.00005
* **Dropout Rate:** Tested 0.4
* **Number of Layers Unfrozen:** Adjusted transfer learning depth – partial unfreezing of deeper layers improved accuracy

Hyperparameter tuning was done using **KerasTuner**, and the optimal configuration was selected based on validation loss minimization.

**3. Results & Discussion**

**3.1 Key Findings**

* The model achieved **83.7% accuracy** on the test set, exceeding the 80% goal.
* **Misclassifications** were observed in species with similar visual traits.
* Data augmentation helped improve generalization, reducing overfitting.

**5. Future Research**

* Exploring other architectures (e.g., ResNet50 Vision Transformers)
* Incorporating additional metadata (location, time) for species prediction
* Developing an ensemble model for higher accuracy

**3.2 Visualizations**

* **Sample Predictions:** Below is a set of correctly and incorrectly classified images:
* **Confusion Matrix:**

A screenshot of a graph

AI-generated content may be incorrect.

**Training Performance (Accuracy & Loss Curves):**

A graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of a graph of

AI-generated content may be incorrect.

These visualizations illustrate model strengths and areas where misclassification occurs.

**4. Recommendations**

1. **Expand Dataset**: Increase the diversity of training images to improve classification accuracy for rare species.
2. **Fine-Tune Model Further**: Unfreeze deeper layers in ResNet50 to capture more complex features.
3. **Deploy as a Web App**: Develop a user-friendly interface for researchers to upload images and receive automated classifications.

**6. Conclusion**

This project successfully demonstrated that transfer learning can automate wildlife species classification with **high accuracy**. Implementing this solution in conservation efforts can enhance efficiency, reduce manual labor, and improve ecological data analysis.

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| Metrics  Feature |  |  |  |  |  |  |
| Model Architecture | Custom CNN with Fully Connected Layers | | | |  |  |
| Pretrained Base Model | ResNet50 |  |  |  |  |  |
| Image Size | 224x224 |  |  |  |  |  |
| Batch Size | 32 |  |  |  |  |  |
| Learning Rate | 0.0001 |  |  |  |  |  |
| Dropout Rate | 0.5 |  |  |  |  |  |
| Optimizer | Adam |  |  |  |  |  |
| Loss Function | Categorical Crossentropy | | |  |  |  |
| Early Stopping Patience | 3 Epochs |  |  |  |  |  |
| Final Test Accuracy | 83.70% |  |  |  |  |  |
| Final Test Loss | N/A |  |  |  |  |  |