Can You Spot the Pangolin? Building Pangolin-Specific Species Identification Models

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Introduction

- Pangolins are among the least studied mammals and are at high risk of extinction due to increased poaching
- Camera traps provide valuable insight into species populations
- Labeling images is time intensive, which AI can automate.
  - Current tools underperform on underrepresented species like pangolins [1]
- **We aim to improve the detection of pangolins using AI-based species identification models**

Data

- ~400,000 images taken in Cameroon's Dja Faunal Reserve
- Cameras deployed on ground and at 5 different elevations on trees (first arboreal camera trap study of pangolins)
- **206 images of pangolins** (all in trees) and **447 of other species** (297 in trees) for a **total of 653 images** in our data set

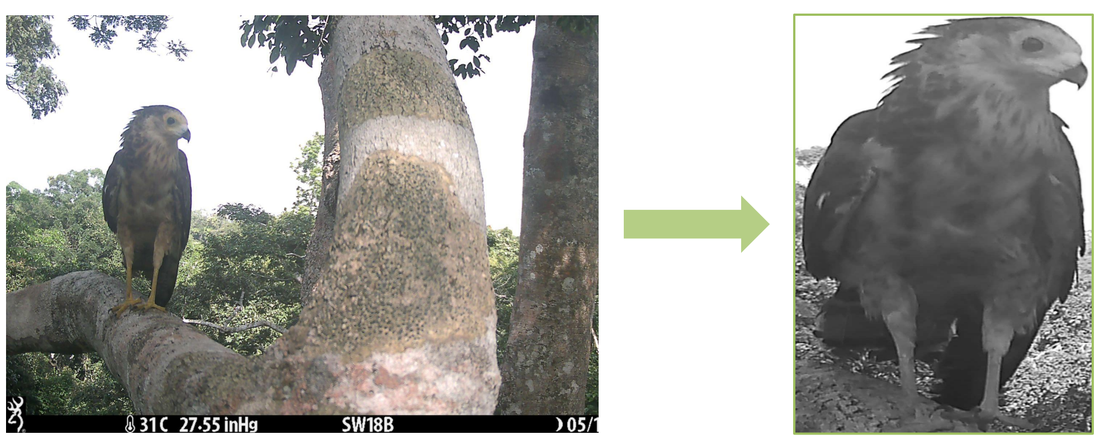

Figure 1. Preprocessing an image of an African Harrier-Hawk

Methods

- **Goal: Classify if each image has a pangolin in it or not**
- 3 pre-trained convolutional neural network models were considered
  - DenseNet pre-trained on ImageNet dataset
  - ResNet50 pre-trained on ImageNet dataset
  - ResNet50 pre-trained on ImageNet dataset and iNaturalist Challenge 2021 mini dataset
- Models were trained using Stratified 5-Fold Cross Validation:
  - Data Split: 72% train set, 8% validation set, 20% test set
- 15 epochs, best epoch selected from lowest validation loss
- Optimized using stochastic gradient descent with binary cross-entropy loss
- 5 evaluation metrics considered:
  - **Accuracy**: number of test images correctly classified as pangolin or non pangolin divided by total number of test images
  - **Precision**: number of pangolin test images correctly classified divided by total number of predicted pangolin test images
  - **Recall**: number of pangolin test images correctly classified divided by total number of true pangolin test images
  - **F1-Score**: harmonic mean of precision and recall
  - **AUC**: measures how well the model can distinguish between pangolin vs. non-pangolin classes

Results

- All 653 Images

	DenseNet pretrained (ImageNet)	ResNet pretrained (ImageNet)	ResNet pretrained (iNat & ImageNet)	DenseNet not pretrained	ResNet not pretrained	ResNet not pretrained (iNat)
Accuracy	0.9724	**0.9859**	0.9831	**0.8730**	0.8213	0.7565
Precision	0.9455	0.9521	**0.9805**	**0.8188**	0.7694	0.4350
Recall	0.9707	**0.9914**	0.9670	**0.7814**	0.6531	0.7106
F1-Score	0.9567	**0.9882**	0.9735	**0.7962**	0.7242	0.4996
AUC	**0.9989**	0.9973	0.9987	**0.9552**	0.9338	0.8796

Figure 2. Comparison of test scores for model trained on the entire dataset

- Only 503 Arboreal Images

	DenseNet pretrained (ImageNet)	ResNet pretrained (ImageNet)	ResNet pretrained (iNat & ImageNet)	DenseNet not pretrained	ResNet not pretrained	ResNet not pretrained (iNat)
Accuracy	0.9741	0.9731	**0.9761**	**0.9483**	0.8128	0.7731
Precision	0.9617	0.9574	**0.9707**	**0.9588**	0.7812	0.5581
Recall	**0.9756**	0.9711	0.9736	**0.9125**	0.6451	0.8369
F1-Score	0.9686	**0.9781**	0.9710	**0.9345**	0.6988	0.6555
AUC	0.9964	0.9947	**0.9977**	**0.9889**	0.8324	0.8751

Figure 3. Comparison of test scores for model trained on the arboreal dataset

- Pre-training achieved very high performance on already good baselines
- DenseNet architecture achieved high baseline performance without pre-training
- Comparable performance across models when pre-training
- Models could predict based on non-animal features (in a tree vs. not in a tree, nighttime vs. daytime)

Figure 4. Misclassified White-bellied Pangolin image (false negative)

Figure 5. Western Tree Hyrax misclassified as pangolin (false positive)

Conclusion

- Pre-training improves identification of pangolins
- Risk of overfitting due to biased data (common depicted locations, all pangolin images in trees, small dataset size)
- Camera deployments in trees not represented in most species identification models

[1] *Schneider, S., Greenberg, S., Taylor, G. W., & Kremer, S. C. (2020). Three critical factors affecting automated image species recognition performance for camera traps. Ecology and Evolution, 10(7), 3503–3517. https://doi.org/10.1002/ece3.6147*