# Machine learning to classify animal species in camera trap images

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# Agenda

- Introduction
- Data
- Machine learning process
- Result
- My opinion

# Introduction

- Camera traps are increasingly used to remotely observe wildlife over large geographical areas with minimal human involvement and Have made considerable contributions to ecology.
- A common limitation is these methods lead to a large accumulation of images which must be first classified in order to be used in ecological studies.
- The burden of manually viewing and classifying images often constrains studies by reducing the sampling intensity

# Data

- Species in camera trap images from six different locations across the United States and Canada.
- If any part of an animal (e.g., ear) was identified as being present in an image, this was included as an image of the species.

# Data

- If an image did not contain any animals, it was classified as empty.
- This resulted in a total of 3,741,656 classified images that included 27 species or groups.
- They randomly selected 90% of the classified images for each species or group to train the model and 10% of the images to test it.

# Machine learning process

- They trained a deep convolutional neural network using the TensorFlow framework.
- They used the ReLU activation function, 55 epochs, a backpropagation algorithm of Stochastic Gradient Descent with Momentum and the learning rate (η) and weight decay varied by epoch number.

# RESULTS

- the model performed well, achieving 97.6% accuracy of identifying the correct species with the top guess.
- The top-5 accuracy was >99.9%.
- The model confidence in the correct answer varied, but was mostly >95%
- there was not a large effect of daytime versus night-time on accuracy in the model, as daytime accuracy was 98.2% and night- time accuracy was 96.6%.

# Cont.

- using the model to evaluate images of ungulates from Canada the overall accuracy was 81.8% .
- For discover if the image is empty or not, 85.1% were classified correctly as empty, while 94.3% of images containing an animal were classified correctly.
- the trained model was capable of classifying approximately 2,000 images per minute on a Macintosh laptop with 16 gigabytes of RAM.

**(a)** Correct classification by model

**(b)** Incorrect classification by model

**(a)**

| Model Guess | Confidence (%) |
|---|---|
| Wild pig | 96.11 |
| Cattle | 2.38 |
| Empty | 1.49 |
| White-tailed deer | <0.1 |
| Moose | <0.1 |

**Answer from human classifiers: Wild pig**

**(b)**

| Model Guess | Confidence (%) |
|---|---|
| Wild pig | 48.82 |
| Cattle | 31.27 |
| Moose | 16.93 |
| Black bear | 2.51 |
| Bobcat | 0.51 |

**Answer from human classifiers: Cattle**

**FIGURE 1** Examples of images that could be difficult to classify. The model correctly identifies a wild pig (a) by seeing only its hindquarters and tail (right side of image). The model incorrectly classifies a cattle as a wild pig (b), as only an ear is visible in the image; note that the model has relatively low confidence in the top guess for this image. Nevertheless, cattle are within the top-5 guesses for this image, so while it is incorrect, it counts towards the top-5 recall for cattle

**TABLE 1** Model performance for each species or group

| Species or group name | Scientific name | Number of training images | Number of test images | Recall | Top-5 recall | Precision | False-positive rate | False-negative rate |
|---|---|---|---|---|---|---|---|---|
| Moose | *Alces alces* | 8,967 | 997 | 0.98 | 1.00 | 0.98 | 0.02 | 0.02 |
| Cattle | *Bos taurus* | 1,817,109 | 201,903 | 0.99 | 1.00 | 0.99 | 0.01 | 0.01 |
| Quail | *Callipepla californica* | 2,039 | 236 | 0.91 | 0.96 | 0.93 | 0.07 | 0.09 |
| Canidae | Canidae | 20,851 | 2,321 | 0.89 | 0.99 | 0.93 | 0.07 | 0.11 |
| Elk | *Cervus canadensis* | 185,390 | 20,606 | 0.99 | 1.00 | 0.99 | 0.01 | 0.01 |
| Mustelidae | Mustelidae | 1,991 | 223 | 0.77 | 0.99 | 0.87 | 0.13 | 0.23 |
| Corvid | Corvidae | 4,037 | 452 | 0.84 | 1.00 | 0.80 | 0.20 | 0.16 |
| Armadillo | *Dasypus novemcinctus* | 8,926 | 993 | 0.89 | 0.99 | 0.93 | 0.07 | 0.11 |
| Turkey | *Meleagris gallopavo* | 3,919 | 447 | 0.90 | 1.00 | 0.90 | 0.10 | 0.10 |
| Opossum | *Didelphis virginiana* | 1,804 | 210 | 0.79 | 0.96 | 0.88 | 0.12 | 0.21 |
| Horse | *Equus spp.* | 2,517 | 281 | 0.94 | 0.99 | 0.94 | 0.06 | 0.06 |
| Human | *Homo sapiens* | 88,667 | 9,854 | 0.96 | 1.00 | 0.97 | 0.03 | 0.04 |
| Rabbits | Leporidae | 17,768 | 1,977 | 0.95 | 1.00 | 0.96 | 0.04 | 0.05 |
| Bobcat | *Lynx rufus* | 22,889 | 2,554 | 0.91 | 0.99 | 0.94 | 0.06 | 0.09 |
| Striped skunk | *Mephitis mephitis* | 10,331 | 1,154 | 0.95 | 0.98 | 0.96 | 0.04 | 0.05 |
| Rodent | Rodentia | 3,279 | 366 | 0.79 | 0.98 | 0.88 | 0.12 | 0.21 |
| Mule deer | *Odocoileus hemionus* | 87,700 | 8,543 | 0.98 | 1.00 | 0.98 | 0.02 | 0.02 |
| White-tailed deer | *Odocoileus virginianus* | 87,900 | 1,360 | 0.94 | 1.00 | 0.95 | 0.05 | 0.06 |
| Raccoon | *Procyon lotor* | 42,948 | 4,781 | 0.90 | 1.00 | 0.89 | 0.11 | 0.10 |
| Mountain lion | *Puma concolor* | 13,272 | 1,484 | 0.92 | 0.98 | 0.97 | 0.03 | 0.08 |
| Squirrel | *Sciurus spp.* | 59,072 | 6,566 | 0.97 | 1.00 | 0.95 | 0.05 | 0.03 |
| Wild pig | *Sus scrofa* | 287,017 | 31,893 | 0.98 | 1.00 | 0.98 | 0.02 | 0.02 |
| Fox | *Vulpes vulpes and Urocyon Cinereoargenteus* | 10,749 | 1,204 | 0.91 | 0.99 | 0.94 | 0.06 | 0.09 |
| Black bear | *Ursus americanus* | 79,628 | 8,850 | 0.95 | 1.00 | 0.98 | 0.02 | 0.05 |
| Vehicle | | 23,413 | 2,602 | 0.93 | 1.00 | 0.95 | 0.05 | 0.07 |
| Bird | Aves | 61,063 | 6,787 | 0.94 | 1.00 | 0.95 | 0.05 | 0.06 |
| Empty | | 414,119 | 46,016 | 0.96 | 1.00 | 0.94 | 0.06 | 0.04 |
| Total | | 3,367,365 | 364,660 | 0.98 | 1.00 | 0.98 | | |

# My opinion

- I think this application will be so helpful for remotely observing wildlife.
- The paper was too simple and didn't mention many details about the work  I think this is good and bad point at the same time.
- The authors ignore some important points (e.g., pervious work in this field and compare their result by the current models in that field),
- The paper need more graphs and figures.

# Any questions ?