Reproducibility Experiment for Carl et al. (2020)

ADD SUBTITLE

Tobias Abraham Haider[1]
Vienna University of Technology
University of Veterinary Medicine Vienna

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Abstract

This experiment attempts to reproduce the results of the paper Carl et al. [2020], which tests the pretrained Google Inception-ResNet-v2 model for predicting animal species. We describe the required software, image loading processes, model outputs. Furthermore we calculate prediction global and per-class prediction accuracies and compare them to the metrics from the original paper.

Keywords machine learning, reproducibility, animal species classification, computer vision, neural networks, cnn, resnet, tensorflow, wildlife monitoring

1 Dependencies

```
from pathlib import Path
from PIL import Image
import numpy as np
import pandas as pd
import tensorflow as tf
from tensorflow.keras.applications import InceptionResNetV2
from tensorflow.keras.applications.inception_resnet_v2 import decode_predictions
from sklearn.metrics import accuracy_score, confusion_matrix
import matplotlib.pyplot as plt
import seaborn as sns
```

2 Model

```
model = InceptionResNetV2(weights="imagenet")
```

3 Data

For the experiment, 90 common animals are used. They are sourced from Google images and provided in a labeled format in Banerjee [2024]. The Kaggle dataset is rather large. To mimic the original experiment setup, only 10 samples are used for each species.

3.1 Data Preprocessing

The images are loaded with three color channels (RGB), resized to 299 by 299 pixels and converted into an 1-dimensional vector. The color intensities are scaled to be floating point numbers from 0 to 1. This is the minimal preprocessing required to fit the required input size of the neural network.

[1]Correspondence to: e11833743@student.tuwien.ac.at

```
def load_normalized_image(path, target_size=model_input_size):
    image = Image.open(path).convert("RGB")
    image = image.resize(target_size)
    return np.array(image) / 255.0
```

The testing data is constructed by stacking the vectors and using the folder names as the label.

```
animal_images = [load_normalized_image(p) for p in wildlife_image_paths]
animal_species = [p.parent.name for p in wildlife_image_paths]

X_test = np.stack(animal_images, axis=0)
y_true = animal_species
```

4 Test

To relate the output from the neural network to the labels from the dataset, only the output from the top neuron of the final softmax layer is used for each prediction.

```
y_pred = model.predict(X_test)
y_pred = [pred[0][1] for pred in decode_predictions(y_pred, top=1)]
```

When comparing the true labels and the predictions, it becomes apparent, that the model actually yields usable results. Almost all inference outputs are animal species somehow related to the one present in the image. This shows that the InceptionResNetV2 is generalizable to some extent.

4.1 Label Mapping

One big issue with this experiment is the set of classes known to the model which do not match the dataset used for testing. To calculate some sensible performance metrics, the animal species labels need to be mapped

Table 1: Imagenet label mapping

mapped label	imagenet label
antelope	gazelle, impala
bear	American_black_bear, brown_bear
beetle	ground_beetle, leaf_beetle, rhinoceros_beetle, dung_beetle
boar	wild_boar
butterfly	ringlet, monarch, sulphur_butterfly, lycaenid
cat	Egyptian_cat, tabby, Siamese_cat, Persian_cat, lynx
cow	ox, water_buffalo
crab	Dungeness_crab
deer	red_deer, elk
dog	Labrador_retriever, Border_collie, Chihuahua, Bouvier_des_Flandres, Brittany_spaniel, English_setter, Greater_Swiss_Mountain_dog, Ibizan_hound, Mexican_hairless, Pekinese, Pomeranian, golden_retriever, pug
donkey	ass
duck	mallard
eagle	bald_eagle, golden_eagle
elephant	African_elephant, Indian_elephant
fox	Arctic_fox, red_fox
goat	ibex, mountain_goat
horse	Arabian_horse, Appaloosa
kangaroo	wallaby
lizard	agama, alligator_lizard, Komodo_dragon
lobster	American_lobster
mouse	house_mouse

first. Note that this results in lost semantic information, because multiple species are often mapped to one single family (e.g., American Black Bear and Brown Bear are both mapped to simply bear). View Table 1 for details.

5 Evalution

6 Summary

7 Future Work

References

Christin Carl, Fiona Schönfeld, Ingolf Profft, Alisa Klamm, and Dirk Landgraf. Automated detection of European wild mammal species in camera trap images with an existing and pre-trained computer vision model. *European Journal of Wildlife Research*, 66(4), 7 2020. ISSN 1439-0574. doi:10.1007/s10344-020-01404-y. URL http://dx.doi.org/10.1007/s10344-020-01404-y.

Sourav Banerjee. Animal Image Dataset (90 Different Animals). https://www.kaggle.com/datasets/iamsouravbanerjee/animal-image-dataset-90-different-animals, 2024. URL https://www.kaggle.com/datasets/iamsouravbanerjee/animal-image-dataset-90-different-animals. Accessed: 2025-09-03.

Table 2: Inception-ResNet-v2 predictions

truth	mapped prediction	model prediction
antelope	antelope	gazelle
antelope	antelope	impala
antelope	antelope	impala
antelope	antelope	gazelle
antelope	antelope	gazelle
antelope	antelope	impala
antelope	goat	ibex
antelope	antelope	gazelle
antelope	antelope	impala
antelope	antelope	impala
badger	badger	badger
badger	badger	badger
badger	badger	badger
badger	badger	badger
badger	bear	American_black_bear
badger	badger	badger
badger	badger	badger
badger	badger	badger
badger	badger	badger
badger	badger	badger
bat	hummingbird	hummingbird
bat	wood_rabbit	wood_rabbit
bat	hook	hook
bat	hummingbird	hummingbird
bat	cowboy_boot	cowboy_boot
bat	barracouta	barracouta
bat	house_finch	house_finch
bat	chime	chime
bat	cat	tabby
bat	mink	mink
bear	bear	brown_bear
bear	bear	brown_bear
bear	bear	American_black_bear
bear	bear	brown_bear
bear	bear	American_black_bear
bear	bear	brown_bear
bear	bear	brown_bear
bear	bear	American_black_bear
bear	bear	brown_bear
bear	bear	brown_bear
bee	bee	bee
bee	bee	bee
bee	honeycomb	honeycomb
bee	bee	bee
bee	bee	bee
bee	bee	bee
bee	bee	bee
bee	bee	bee
bee	bee	bee
bee	bee	bee
beetle	honeycomb	honeycomb
beetle	beetle	ground_beetle
beetle	fly	fly
beetle	beetle	ground_beetle
beetle	cockroach	cockroach
beetle	beetle	leaf_beetle
beetle	beetle	ground_beetle
beetle	beetle	rhinoceros_beetle
beetle	beetle	rhinoceros_beetle
beetle	beetle	dung_beetle
bison	bison	bison
bison	bison	bison
bison	bison	bison
bison	bison	bison