Reproducibility Experiment for Carl et al. (2020)

ADD SUBTITLE

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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 original dataset is rather large. To mimic the original experiment, only 10 samples are taken 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 n 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.

TODO Add example image as figure TODO

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```
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 # 1d array with floats from 0 to 1 as input for neural network

wildlife_images = []
labels = []

animal_species = sorted([d.name for d in DATA_PATH.iterdir() if d.is_dir()])

for species_name in animal_species:
    animal_image_folder = DATA_PATH / species_name # every species has its image folder
    for image_path in animal_image_folder.glob("*.jpg"):
        image_array = load_normalized_image(image_path)
        wildlife_images.append(image_array)
        labels.append(species_name)

X_test = np.stack(wildlife_images, axis=0)
y_true = labels
```

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 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 1: Imagenet label mapping

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