# 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

As the exact dependencies are not provided, state-of-the-art packages are chosen and installed and imported. The exact versions are shown in Table 1.

```
!python3.12 -m pip install -r requirements.txt
```

## 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.

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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
```

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: Runtime dependencies

| package | version |
|---|---|
| pathlib | 1.0.1 |
| tabulate | 0.9.0 |
| Pillow | 11.3.0 |
| numpy | 2.1.3 |
| pandas | 2.3.1 |
| tensorflow | 2.19.0 |
| scikit-learn | 1.7.1 |
| matplotlib | 3.10.5 |
| seaborn | 0.13.2 |

Table 2: 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 2 for details.

Table 3: 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 |

## 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.

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