Software, Data & Models used in *"Identifying Animal Species in Camera Trap Images using Deep Learning and Citizen Science"*

The following sections describe the software/code, meta-data and models used in the study "Identifying Animal Species in Camera Trap Images using Deep Learning and Citizen Science". The camera-trap images were published separately. Excluded are meta-data about the "Elephant Expedition" dataset which is being published outside DRUM (the models are available).

Software

The software (Python code) used to train and apply the models used in the study has been published on Zenodo https://doi.org/10.5281/zenodo.1426139, as well as via DRUM. The code and instructions are contained in the following file:

code.tar.gz

Unpacking the files

The files can be unpacked using the following unix-command.

tar -xf code.tar.gz

Other programs can be used to unpack such files as well.

Meta-Data

The following file contains all the meta-data describing the data used to train each of the models:

all_meta_data.tar.gz

Unpacking the File

The file can be unpacked using the following unix-command.

tar xvzf all_meta_data.tar.gz

Other programs can be used to unpack such files as well.

File Structure

The file contains the following directory structure:

dataset/
  meta_data1.json
  meta_data2.json

Example :
camera_catalogue/
camera_catalogue/subject_set_used.json
camera_catalogue/test_subject_set_cc_blank_vehicle_species.json
camera_catalogue/test_subject_set_cc_blank_vehicle_species_v2.json

Each dataset contains a file describing the full dataset:

subject_set_used.json

Additionally, each dataset contains for each experiment / model the train/test/validation splits. For example: the Snapshot Serengeti species model was trained using the following files:

ss/test_subject_set_ss_species_51.json
ss/train_subject_set_ss_species_51.json
ss/val_subject_set_ss_species_51.json

Each file has the exact same structure and is a subset of *subject_set_used.json*. These files are only useful for re-running the experiments in the study using the provided software.

File Content

Each json-file (a common human and machine-readable file) contains one entry per capture event which consists of 1 or more images. Each entry is identified by its capture-id and has the following fields:

- *fnames*: a list with the image file names
- *img_ids*: a list with the image names
- *file_paths*: a relative path to where the images are save*d*
- *urls:* a list of urls of the source (original) images downloaded via Zooniverse
- *meta_data*: key/value pairs with the following keys (not always available):
    - location: the location identifier of where the images were taken
    - pielou: pielous evenness index of the citizen science annotations (a value of 0 means complete agreement among all volunteers, a value of 1 means complete disagreement).
    - time: the time of the day HHMMSS of when the photos were taken (000000 if unknown)
    - n_species: the number of species / classes in the images
    - n_users: the number of volunteer annotations used to determine the label / class
    - date: the date of when the images were taken (YYYYMMDD)
    - datetime: the date and time of when the images were taken (YYYMMDDHHMMSS)
- label: a list of class labels for the images

Example:

"9909433": {"img_ids": ["9909433_0"], "meta_data": {"pielou": 0, "time": "000000", "n_species": 1.0, "location": "C1055864", "datetime": "20010101000000", "date": "20010101", "n_users": 3}, "urls": ["https://s3-eu-west-1.amazonaws.com/pantherabucketleopard1/25_2017/C1055864.JPG"], "label": ["elephant"], "file_paths": ["all/elephant/"], "fnames": ["9909433_0.jpeg"]},

The "9909433" refers to the capture-id. The capture contains one image with name "9909433_0.jpeg" that is stored in "all/elephant/"and is of label "elephant".

File Size

Note that the .json files can be quite large. The largest file is 1.1 GB which may be too large to open in a text editor or to load into memory using a program like Python on computers with low memory. The files are intended to be processed with a program, for example, to train a model. Memory is normally not an issue in such cases because a powerful computer is required for training models anyway (which presumably has also enough memory). The exact memory requirement to open the larger .json files is unclear, however, we recommend at least 8 GB RAM, preferably 16 GB or more.

Models

The following file contains the models trained in the study:

models.tar.gz

Unpacking the File

The file can be unpacked using the following unix-command.

tar xvzf models.tar.gz

Other programs can be used to unpack such files as well.

File Structure

The file contains the following directory structure:

dataset/
  model1.hdf5
  model1_cfg.json

Example :
camera_catalogue/
camera_catalogue/cc_blank_vehicle_species_v2_201708200608_cfg.json
camera_catalogue/cc_blank_vehicle_species_v2_201708200608.hdf5

Available Models

The following models are available as described in the study. Each model file (*.hdf5) is accompanied by a configuration file (*.json) with the same prefix. To use the models we refer to the description of the software which contains detailed explanations and examples.

Snapshot Serengeti

Empty model:
- ss_blank_vs_non_blank_small_201711150811.hdf5

Species model:
- ss_species_51_201708072308.hdf5

Snapshot Wisconsin

Empty model - from scratch:
- sw_blank_vs_nonblank_uncropped_201709150309.hdf5

Empty model - transfer-learning:
- sw_blank_vs_nonblank_uncropped_blank_last_layer_only_201712171812.hdf5

Species model - from scratch:
- sw_species_uncropped_201709120509.hdf5

Species model - transfer-learning:
- sw_species_ss51_last_layer_only_201710290510.hdf5

Camera CATalogue

Empty model:
- cc_blank_vehicle_species_v2_201708200608.hdf5

Empty model - transfer-learning:
- cc_blank_vehicle_species_v2_ss_last_layer_201712160112.hdf5

Species model - from scratch:
- cc_species_v2_201708210308.hdf5

Species model - transfer-learning:
- cc_species_ss51_last_layer_only_201708221508.hdf5

Species model - from scratch - 75%:
- cc_species_75p_train_201710150710.hdf5

Species model - transfer-learning - 75%:
- cc_species_75p_train_ss_last_layer_201710161810.hdf5

Species model - from scratch - 50%:
- cc_species_50p_train_201710152110.hdf5

Species model - transfer-learning - 50%:
- cc_species_50p_train_ss_last_layer_201710170510.hdf5

Species model - from scratch - 25%:
- cc_species_25p_train_201710160310.hdf5

Species model - transfer-learning -25%:
- cc_species_25p_train_ss_last_layer_201710171410.hdf5

Species model - from scratch - 12.5%:

- cc_species_12_5p_train_201710171810.hdf5

Species model - transfer-learning - 12.5%:

- cc_species_12_5p_train_ss_last_layer_201710180310.hdf5

Elephant Expedition

Empty model:

- ee_blank_vs_nonblank_v2_201708231608.hdf5

Empty model - transfer-learning:

- ee_blank_vs_nonblank_v2_blank_last_layer_only_201712151812.hdf5

Species model - from scratch:

- ee_nonblank_no_cannotidentify_new_subject_201708180508.hdf5

Species model - transfer-learning:

- ee_nonblank_no_ci_ss51_last_layer_only_v2_201709180209.hdf5