Deploying species identification models on camera traps and web application for automatic monitoring of animal species in conservation areas

Center for Data Science and Artificial Intelligence (DSAIL) - DeKUT

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Introduction

- Over 400 known wildlife animal species in Africa are endangered
- Conservation through monitoring
- Camera trap image data collection and processing is manual, expensive and time consuming
- Camera traps image big data problem (76% of Snapshot Serengeti dataset is labelled empty) (Swanson et al. 2015)
- Each study generates thousands and millions of camera trap imagery

Fig 1: Shows elephant carcass in Botswana's Okavango Delta. source BBC News 2nd July 2020

Fig 2: Shows fire outbreak in Tsavo National Park in Kenya. Source: pulselive.co.ke 23rd July 2020

Justification

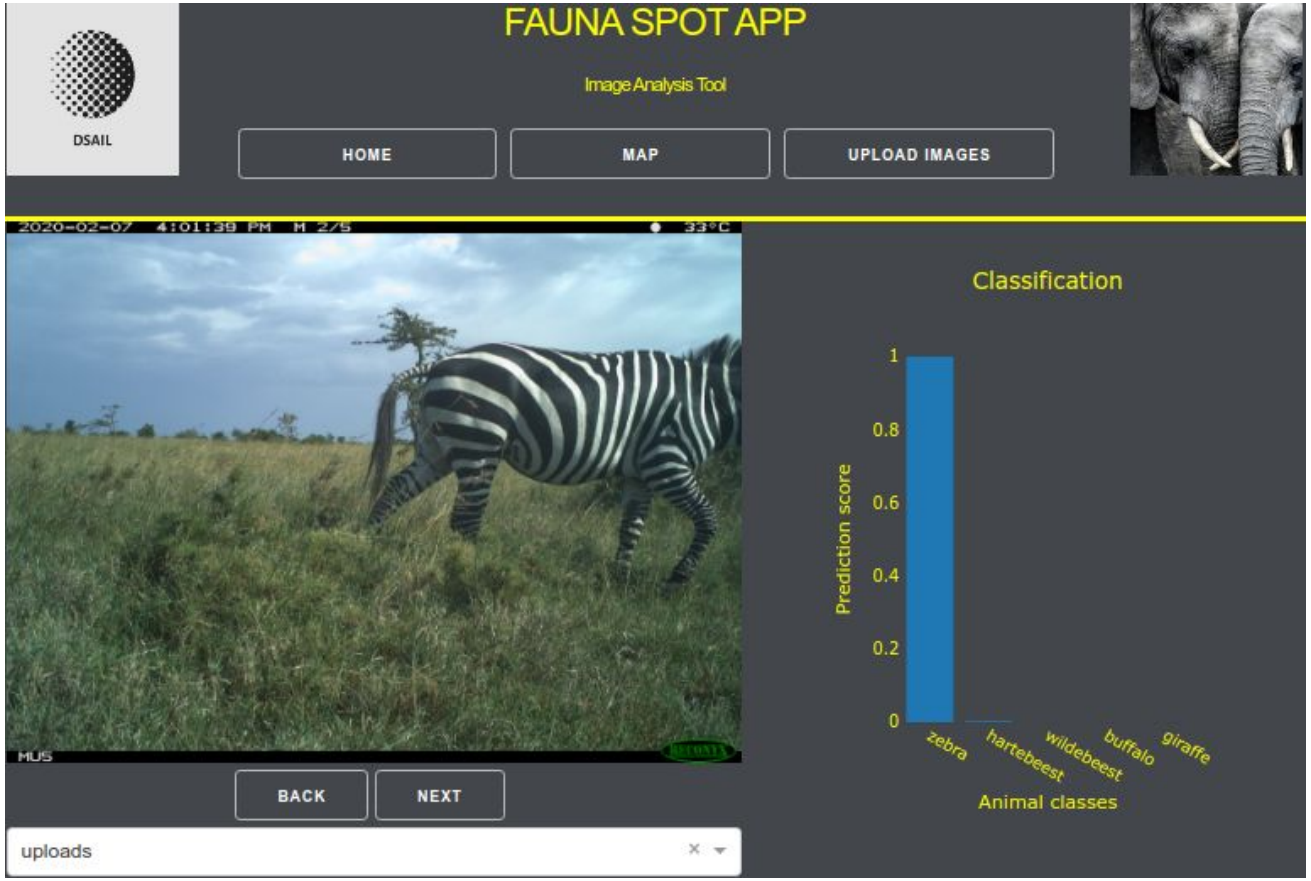

Fig 3: Shows a camera trap image analysis application in the preliminary work

- Transfer learning using state of art pre-trained models
- Snapshot Serengeti and Ol Pejeta datasets
- Camera trap Image analysis application
- Use of non-invasive methods such as camera traps
- Raspberry Pi and edge computing (ML on Arm based microprocessors)

Camera trap Image analysis

Fig 4: Shows a camera trap image at Ol Pejeta wildlife conservancy in Nanyuki, Kenya

- Identify animal species, location, count and activity
- Process Images close to the source i.e edge computing(Magid et al. 2020)
- Analyse unlabelled datasets using web application
- Camera trap image processing pipeline.

Methodology

Existing methods

- State of art pre-trained keras models e.g ResNet50, VGG16 and Inception_V3.
- Image classification (Rawat & Wang 2017).
- Existence of Image datasets e.g ImageNet, COCO and iNaturalist
- Classify over 1000 object classes
- Train models from scratch (require large datasets) and are less accurate

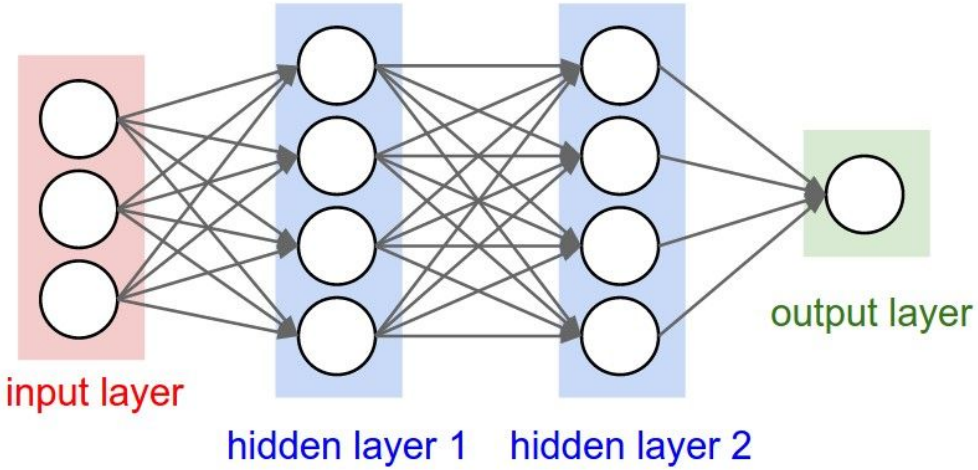

Fig 5
Shows illustration of classification using a neural network. Source : Convolutional Neural Networks

Strategy

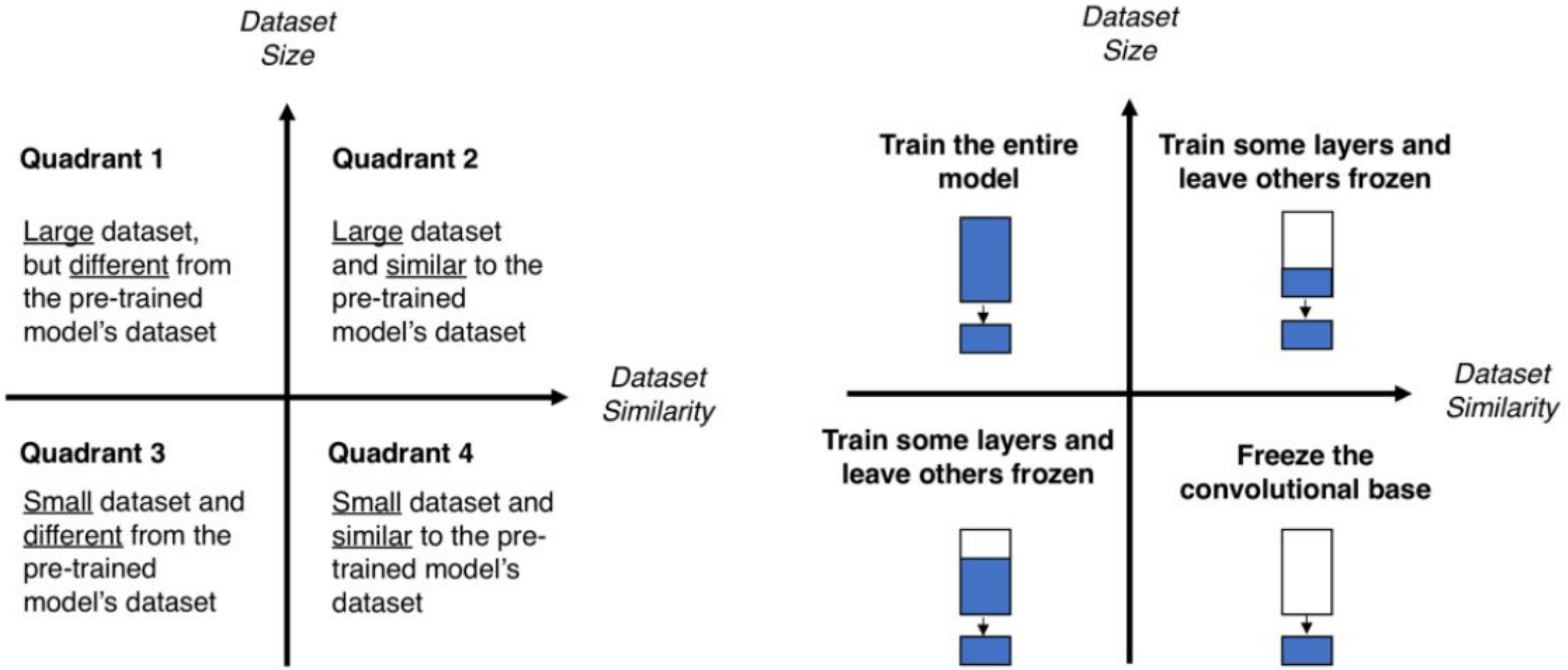

Fig 6

Shows size-similarity matrix. source: Size-Similarity matrix (left) and decision map for fine-tuning pre-trained models (right).

Datasets

- Snapshot Serengeti Dataset
- Ol-pejeta sample data Images

- Total of 53, 499 JPG images
- Belong to 60 classes (Snapshot)
- Imbalanced data

Fig 7
Shows a sample of Camera trap images from Snapshot Serengeti dataset(top left and top right), and Ol Pejeta dataset

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Development tools

- Top 10 most frequent species
- Finetune VGG16 and ResNet50
- 70% Train and 30% Validation
- Test using Ol Pejeta dataset
- Developed dash web application
- Deployed the model
- Functionalities

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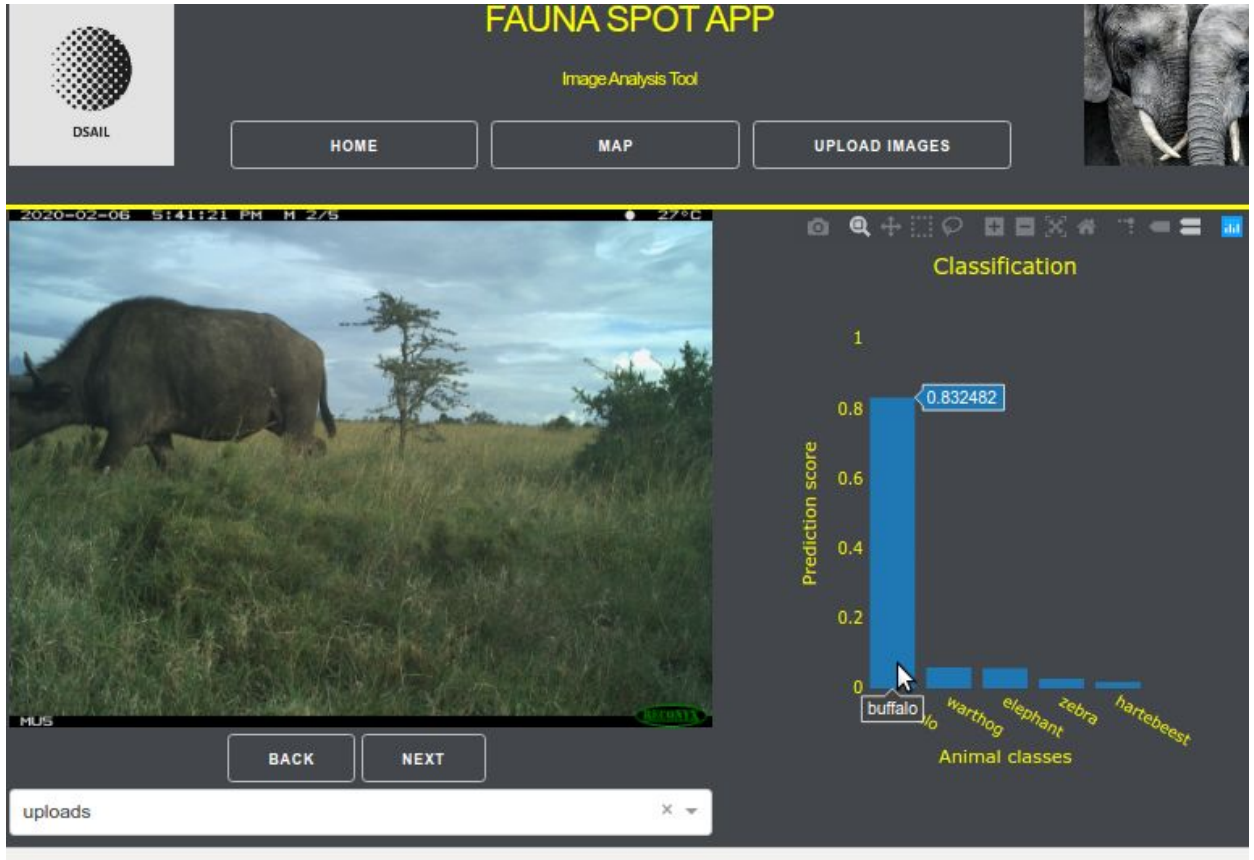
Web Application



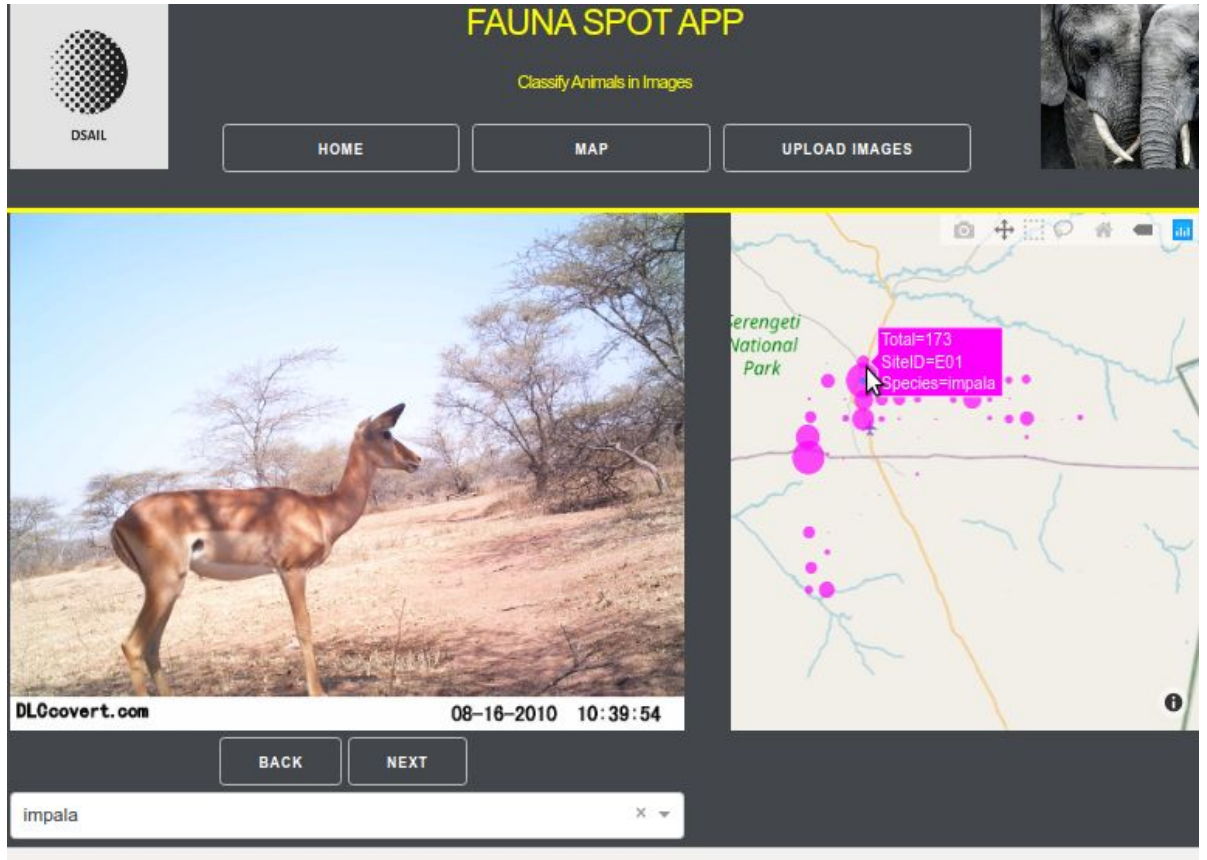


Fig 8: Shows image classification (left) , species distribution and location

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What's Next?

- Scale to identify more species
- Deploying species identification models on camera traps
- Assemble and deploy camera traps at Ol Pejeta conservancy
- Benchmark other models

Architecture

- Deep learning learning methods (Transfer learning)
- Finetune state of art pretrained model (ResNet50)
- Deploy fine tuned model on dash web application
- Leverage Raspberry Pi 4B and LoRA IoT network for edge computing and data transmission to cloud server

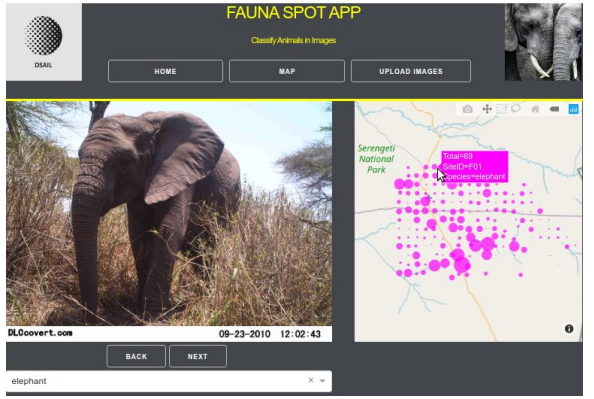

Image processing & Visualization application

THE THINGS NETWORK

LoRa network server

Motion sensor, Raspberry Pi camera, Raspberry Pi 4B + LoRa shield

LoRa gateway

Fig 9: Shows flow diagram of camera trap inference data transmission over lora network

- Motion detection (Motion sensors)
- Raspberry Pi Cameras
- Image filtering and SD card storage
- Image processing on Raspberry Pi 4B based camera trap
- Inference transmission via LoRa transceiver shield and gateway to TTN
- Data visualization on the web application
- Demystifying AI on Arm MCUs

Fig 8: Shows Raspberry Pi 4B

Fig 10: Shows a camera trap deployed in Serengeti national Park. souce: https://www.nature.com/articles/sdata201526

Thank You

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