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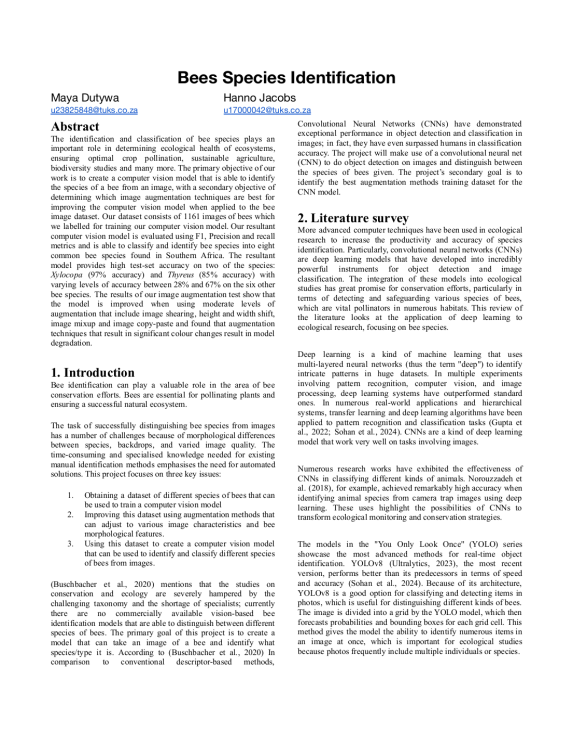

Bees Species Identification

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Abstract

The identification and classification of bee species plays an important role in determining ecological health of ecosystems, ensuring optimal crop pollination, sustainable agriculture, biodiversity studies and many more. The primary objective of our work is to create a computer vision model that is able to identify the species of a bee from an image, with a secondary objective of determining which image augmentation techniques are best for improving the computer vision model when applied to the bee image dataset. Our dataset consists of 1161 images of bees which we labelled for training our computer vision model. Our resultant computer vision model is evaluated using F1, Precision and recall metrics and is able to classify and identify bee species into eight common bee species found in Southern Africa. The resultant model provides high test-set accuracy on two of the species: *Xylocopa* (97% accuracy) and *Thyreus* (85% accuracy) with varying levels of accuracy between 28% and 67% on the six other bee species. The results of our image augmentation test show that the model is improved when using moderate levels of augmentation that include image shearing, height and width shift, image mixup and image copy-paste and found that augmentation techniques that result in significant colour changes result in model degradation.

1. Introduction

Bee identification can play a valuable role in the area of bee conservation efforts. Bees are essential for pollinating plants and ensuring a successful natural ecosystem.

The task of successfully distinguishing bee species from images has a number of challenges because of morphological differences between species, backdrops, and varied image quality. The time-consuming and specialised knowledge needed for existing manual identification methods emphasises the need for automated solutions. This project focuses on three key issues:

1. Obtaining a dataset of different species of bees that can be used to train a computer vision model
2. Improving this dataset using augmentation methods that can adjust to various image characteristics and bee morphological features.
3. Using this dataset to create a computer vision model that can be used to identify and classify different species of bees from images.

(Buschbacher et al., 2020) mentions that the studies on conservation and ecology are severely hampered by the challenging taxonomy and the shortage of specialists; currently there are no commercially available vision-based bee identification models that are able to distinguish between different species of bees. The primary goal of this project is to create a model that can take an image of a bee and identify what species/type it is. According to (Buschbacher et al., 2020) In comparison to conventional descriptor-based methods, Convolutional Neural Networks (CNNs) have demonstrated exceptional performance in object detection and classification in images; in fact, they have even surpassed humans in classification accuracy. The project will make use of a convolutional neural net (CNN) to do object detection on images and distinguish between the species of bees given. The project's secondary goal is to identify the best augmentation methods training dataset for the CNN model.

2. Literature survey

More advanced computer techniques have been used in ecological research to increase the productivity and accuracy of species identification. Particularly, convolutional neural networks (CNNs) are deep learning models that have developed into incredibly powerful instruments for object detection and image classification. The integration of these models into ecological studies has great promise for conservation efforts, particularly in terms of detecting and safeguarding various species of bees, which are vital pollinators in numerous habitats. This review of the literature looks at the application of deep learning to ecological research, focusing on bee species.

Deep learning is a kind of machine learning that uses multi-layered neural networks (thus the term "deep") to identify intricate patterns in huge datasets. In multiple experiments involving pattern recognition, computer vision, and image processing, deep learning systems have outperformed standard ones. In numerous real-world applications and hierarchical systems, transfer learning and deep learning algorithms have been applied to pattern recognition and classification tasks (Gupta et al., 2022; Sohan et al., 2024). CNNs are a kind of deep learning model that work very well on tasks involving images.

Numerous research works have exhibited the effectiveness of CNNs in classifying different kinds of animals. Norouzzadeh et al. (2018), for example, achieved remarkably high accuracy when identifying animal species from camera trap images using deep learning. These uses highlight the possibilities of CNNs to transform ecological monitoring and conservation strategies.

The models in the "You Only Look Once" (YOLO) series showcase the most advanced methods for real-time object identification. YOLOv8 (Ultralytics, 2023), the most recent version, performs better than its predecessors in terms of speed and accuracy (Sohan et al., 2024). Because of its architecture, YOLOv8 is a good option for classifying and detecting items in photos, which is useful for distinguishing different kinds of bees. The image is divided into a grid by the YOLO model, which then forecasts probabilities and bounding boxes for each grid cell. This method gives the model the ability to identify numerous items in an image at once, which is important for ecological studies because photos frequently include multiple individuals or species.