Man vs Machine: an evaluation of the accuracy of AI detection and identification software for processing wildlife camera trap data at Brookhaven National Laboratory

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Abstract

Across all disciplines, the process of converting raw data to meaningful information is an arduous task. This task grows more laborious as the capacity to collect and store vast amounts of data expands, making identifying and evaluating strategies to mitigate the time and effort of transforming data increasingly necessary. In ecology, remotely triggered trail cameras are used to collect information on wildlife such as species presence, diversity, range, etc. which produces large volumes of raw data in need of review, annotation, and analysis. Machine learning models and artificial intelligence (AI) offer a solution to expedite data processing by automating wildlife detection and classification in images. To further understand the capabilities of AI for processing camera trap images, AddaxAI, a platform that uses machine learning and the open-source model MegaDetector for automatic detection and identification, was evaluated using data from an ongoing camera trap study at Brookhaven National Laboratory on Long Island, NY. Compared to image labels determined by manual review using Timelapse2, it was found that AddaxAI correctly identified and labeled 93.745% of images from a dataset of 11,862. This is consistent with existing literature on the accuracy of MegaDetector and other AI recognition models. These findings highlight the potential utility of integrating AI recognition into camera trap image processing workflows for many camera trap studies while reinforcing their current limitations and the need for additional human review.

Introduction

Modern camera traps have transformed the methods in which many ecologists and conservation biologists study the distribution of wildlife species, their activity patterns, and interactions among ecological communities. Camera traps can be deployed for long periods of time to remotely record wildlife activity.[6] The past two decades have seen the rapid expansion of and accessibility to this technology.[3, 6]

Though they are more accurate and cost-effective than traditional field surveys, this method of monitoring wildlife over large spatial and temporal scales can produce enormous volumes of raw data.[2, 5] The timely process of converting mega-datasets into meaningful information reduces the efficiency of camera trap surveys and delays informed action.[2]

AI can be used to reduce processing time by automating two basic tasks: determining wildlife presence and assigning labels to detected animals. When applied to mega-datasets this simple task quickly becomes extremely tedious and arduous for individual researchers. Surveys often deploy multiple cameras at once for long periods of time, which can quickly generate tens of thousands of images in need of review.[1]

AI models are made using a subset of data processed manually to "train" computer algorithms and a create a foundation for future analysis. Machine learning models can be trained for specific locations and/or species and how well it performs depends on the characteristics of the raw data and their associated challenges.[4, 5] Because of this, AI models can overlook and misidentify wildlife when locations change, animals are in motion, small or uncommon species are present, or inanimate objects are in frame.

The purpose of this study was to conduct a sitewide camera trap survey of wildlife at BNL and use a subset of this data to evaluate the accuracy of the AI image recognition model AddaxAI for processing wildlife camera trap images. The goals of this study are to contribute to a multi-year camera survey of wildlife at BNL and report the accuracy and usefulness of AI recognition models for processing camera trap data.

Figure 1. Yellow sites encompass site-wide survey; red/blue sites were used in AI analysis.

Methods

Field Surveys

- 73 sites (yellow) w/ varying vegetation and human presence along roads (Figure 1).
  - 15 sites were used in this study (red and blue) (Figure 1).
- Each rotation consists of 9 cameras deployed for ~2 weeks at a time.
  - 2 rounds occur at once - 18 cameras are always active.
- Cameras were baited w/ fatty acid tablets w/in range to increase animal engagement.

Data Analysis

- All camera trap data was processed through AddaxAI and reviewed using Timelapse2.
  - Manual labelling of vehicle, human, and/or animal presence, count, and species ID.
- AddaxAI was evaluated by true positives, false positives, true negatives, false negatives, and true-false positives (Figure 2-4).

Figure 2. Example of a true positive; two red foxes (P23).

Figure 3. Example of a false-true positive; one white-tailed deer (P45).

Figure 4. Example of a false negative; one tufted titmouse (P03).

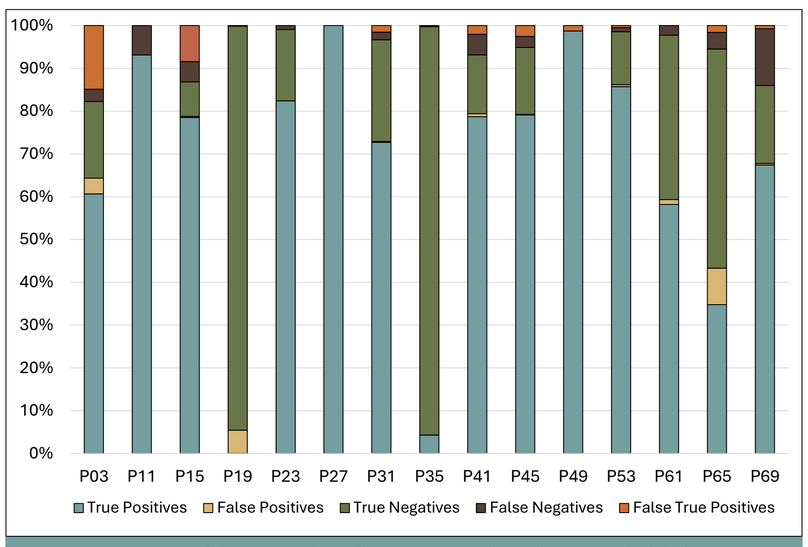

Figure 5. Summary of the proportion of images correctly and incorrectly labeled w/animal presence/absence by Addax AI after manual review.

Results

Camera Trap Data

- Total of **11,884 images** from **15 cameras** were used to evaluate AddaxAI.
  - **4,205 images** contained ≥ 1 animal.
- The most observed animal was white-tailed deer w/ **3,734 individuals** counted (Table 1).

AddaxAI Results

- AddaxAI correctly labeled **93.269% of images** (Figure 5).
  - Includes true positives and true negatives.
- AddaxAI incorrectly labeled **6.741% of images** (Figure 5).
  - Includes false positives, false negatives, and false-true positive.

Species Present	Number of Images with ≥ 1 Animal Present	Count
White-tailed deer	3044	3734
Wild turkey	296	1268
Bird spp.	233	463
Red fox	301	304
Northern raccoon	133	160
Feral cat	87	89
Virginia opossum	40	40
Eastern cottontail	40	40
Southern flying squirrel	10	10
Groundhog	9	9
Arthropod spp.	3	3
Eastern gray squirrel	1	1
Total	**4205**	**6121**

Table 1. Wildlife data collected from 15 camera traps at BNL.

Discussion & Conclusion

It was found that the program AddaxAI, with MegaDetector model incorporated, performed acceptably at detecting wildlife in images collected via motion-triggered camera traps. AddaxAI correctly labeled 93.269% of the 11,884 images processed through the program, a statistic consistent with existing evaluations of MegaDetector's performance.[1] The efficiency of AI processing is entirely dependent on computer hardware and skill of the human reviewer. Image processing using AI models is likely to be more efficient than processing solely by hand, especially when dealing with mega-datasets.

The accuracy of MegaDetector is heavily influenced by vegetation structure, inanimate objects, objects/animals in motion, partially obscured wildlife, and smaller species of wildlife such as birds or rodents. Camera studies often survey large areas of land with diverse flora and fauna; this diversity would result in significant incorrect or partially incorrect AI classifications.

These findings highlight the potential utility of integrating AI recognition models in camera trap image processing workflows for many camera trap studies while reinforcing their current limitations and the need for human review in the analysis process.

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