CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: **Smart software tool for classification of caribou camera collar data**	
Sponsor Information:	
Kathleen Orndahl PhD student, SICCS, NAU kmo265@nau.edu 815-353-7036	*Jim Herriges,* Biologist, Bureau of Land Management, Fairbanks, AK jherrige@blm.gov
Mark Hebblewhite Professor, University of Montana Mark.Hebblewhite@mso.umt.edu	*Mike Suitor* Regional Biologist, Environment Yukon, Dawson, YT Mike.Suitor@gov.yk.ca

Project Overview:

Caribou are the farthest ranging terrestrial mammals in the world, traveling up to 3,000 miles in a single year. They number 5 million worldwide. Caribou populations fluctuate dramatically over time. These animals move vast distances across the landscape, interacting with vegetation and other animals, selecting habitat, living and dying. Caribou are also an extremely important cultural, ecological and economical resource for northern communities and ecosystems. Despite their prevalence, scientists do not fully understand how caribou move across the landscape, how they select habitats and which food items they prefer. Caribou live in some of the most remote areas of the world which has made it difficult for researchers to put themselves in their shoes – that is, until now.

Biologists at the Bureau of Land Management and Environment Yukon have deployed video camera collars on caribou herds in remote areas of Alaska and Canada. These collars take precisely geolocated, 9 second long video clips every 20 minutes, allowing researchers to take an inside look at the lives of Arctic caribou herds. So far, scientists have amassed over 90,000 videos totaling over 3 terabytes of data.


Example still from camera collar video

Like many "big data" efforts, we have gone from not having access to key data to having so much of it that the challenge becomes analyzing it effectively and efficiently. In order to make discoveries about the habits of caribou based on this massive new dataset, we need innovative solutions to help us automatically classify and categorize these video clips. If we can extract information about caribou (number, age, behavior), other animals (predation, insect harassment, cooperation) and vegetation (type, amount, preference) from these videos, we can make enormous strides in understanding why caribou make the behavioral choices they do.

Manual classification of the first collection of video collar data would take a minimum of 1 year, 41 days and 21 hours of human effort. A properly trained and configured AI system could potentially accomplish this task in a fraction of the time. We are thus interested in developing an easy-to-use, highly accurate and generalizable software solution that leverages AI machine learning techniques to extract useful information from terabytes of video collar data. In particular, we envision a system hosted on a server as a secure web app (though the team may suggest a more suitable platform based on requirements acquisition) that serves as a "processing workbench" i.e. it (a) uses sets of existing human-classified video clips to train a deep learning AI framework; and (b) points the trained system at sets of unclassified videos to properly classify them. Human observers have been hard at work and thus a database of calibration/validation data exists. Our ultimate goal is a product that is able to automatically identify, with a high level of accuracy, a series of characteristics from video clips presented to the system.

Key features of our ideal solution would include:

- Accuracy of classification is our main interest and thus the deliverables must include a mechanism for assessing accuracy of the product and comparing it to the accuracy of human based methods.
- Ideally, the product would include a web GUI for soliciting volunteer characterization of video clips to be used in the AI system's "training set". This could grow the training set (and thus AI system's accuracy) very quickly. This GUI should allow volunteer users to register, browse/select video clips, classify them, and add commentary. A truly useful system would allow require that each clip is independently and identically classified by at least X humans (to ensure accuracy) before it is accepted into the training set.
- Ideally, the product would be a unified process that incorporates data from the web interface and implements it into the machine learning algorithm to automatically improve performance.
- The characteristics of our desired software solution are organized into tiers of usefulness/difficulty, to be tackled by the team as feasible (Tier 1 for both characteristics: minimum viable product, Tier 3 for both characteristics: best possible outcome).

		Characteristics	
		System Properties	***Classification Ability***
Tier	***1***	Trains the system based on a set of human-classified videos presented to the system.	AI able to classify videos simply based on video quality to prove the concept. So can classify videos as: • GOOD– allows easy observation; partial to no camera lens obstruction. • FAIR – some data can be collected; partial to significant camera lens obstruction • POOR – unusable data; complete camera lens obstruction.
	2	System has simple web interface to allow volunteers to browse/select videos in the dataset for human classification. Adds new human-classified videos to the training set to improve training of AI system.	AI classifies videos across one or more of the following features, which would start turning this into a truly useful system: • Caribou number • Other animal number • Presence and number of calves • Caribou behavior e.g. moving, standing, feeding, chewing, insect avoidance • Detailed feeding behavior e.g. at ground level, above ground level
	3	A powerful and flexible GUI for allowing volunteers to human-classify videos. Allows things like requiring a certain number of matching human classifications before "accepting" a classification into the training set, a GUI for managing this more advanced process, and a dashboard that allows the system to "assign" videos to classify to various volunteers.	AI system can perform even more complex/advanced classification, i.e., based on one or more of the following: • Part of habitat visible (just ground vs. ground and surrounding vegetation) • Predominant vegetation type e.g. tundra, forest, unvegetated • Presence of habitat traits e.g. burned areas, manmade structures, snow, water • Vegetation to plant functional type (e.g. shrub, grass), family or genus level

Our primary interest is classification, but the team should keep in mind that some of the classification tasks outlined here might not require the full videos. For example, classification of predominant vegetation type might be accomplished using X still images pulled from the full video which would simplify the required AI architecture.

A successful tool will be a game changer for wildlife ecologists' understanding of caribou biology, and will propel forward the use of camera collars to look behind the scenes at caribou behavior…as well as potentially for other animal studies. If the team is able to tackle the challenge of classifying vegetation this will be the first time this type of classification has been done with video data.

Knowledge, skills, and expertise required for this project:

- Basic understanding of machine learning algorithms/AI, or willingness to learn.
- Expertise with Python or other appropriate language for implementation of machine learning algorithms.
- Experience with modern web2.0 design for constructing web based volunteer input platform.
- Familiarity with GUI design.
- No equipment required other than a development platform and software/tools freely available online.
- The client will provide expertise in classification of videos and well as access to existing efforts exploring similar classification challenges, particularly based on videos.

Software and other Deliverables:

- A machine learning oriented algorithm capable of meeting one or more of the usability tiers outlined above.
- Classified video clips for a subset of the data provided to demonstrate completion of the above deliverable.
- A web based interface for volunteers to view video clips and manually classify video characteristics.
- A report detailing the design and implementation of the product in a complete, clear and professional manner. This document should include a detailed accuracy assessment of the algorithm with discussion on strengths and weaknesses, and clear directions for future implementation of the algorithm.
- Complete professionally-documented codebase, delivered both as a repository in GitHub, BitBucket, or some other version control repository; and as a physical archive on a USB drive.