

### Goals

- Assist ecologists by **automatically generating labels** for species and individual animals in camera trap images.
- Enable more **efficient annotation** of large-scale camera trap data.
- Provide a **faster and more accurate** identification method.

### Approach

- Develop a computer vision pipeline to recognize the presence of different **animal species**.
- Perform **individual identification** on jaguars using a hand-crafted feature matching approach.

### Costa Rica Camera Trap Dataset

None	Peccary	Puma	Ocelot	Jaguar	Human
11139	282	119	48	691	437
Tapir	Agouti	Curassow	Deer	Guan	Other
141	109	1985	3497	59	1078

Distribution of species in the labeled camera trap dataset.

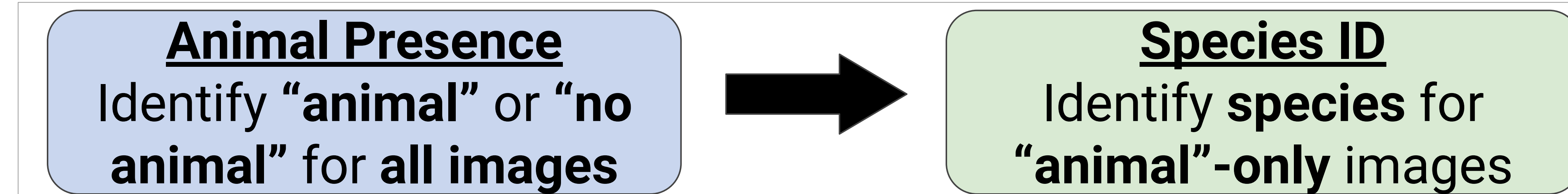
- Obtained from faculty and researchers in the UMass Amherst Department of Environmental Conservation and the Universidad Nacional de Costa Rica.
- **~300,000 images** of wildlife taken from motion-activated camera traps located throughout Costa Rica.
- **~20,000 images currently labeled** with 12 different IDs (shown in table above).
- Photos range from **low to high quality**, some in **color** and some **grayscale**, with varying levels of **illumination**.
- Over half of the images are of **moving plants** (no animal) that activated the motion sensors.
- For our experiments, this labeled dataset was split into **80% training** and **20% validation**.

### Species Identification in Camera Trap Images



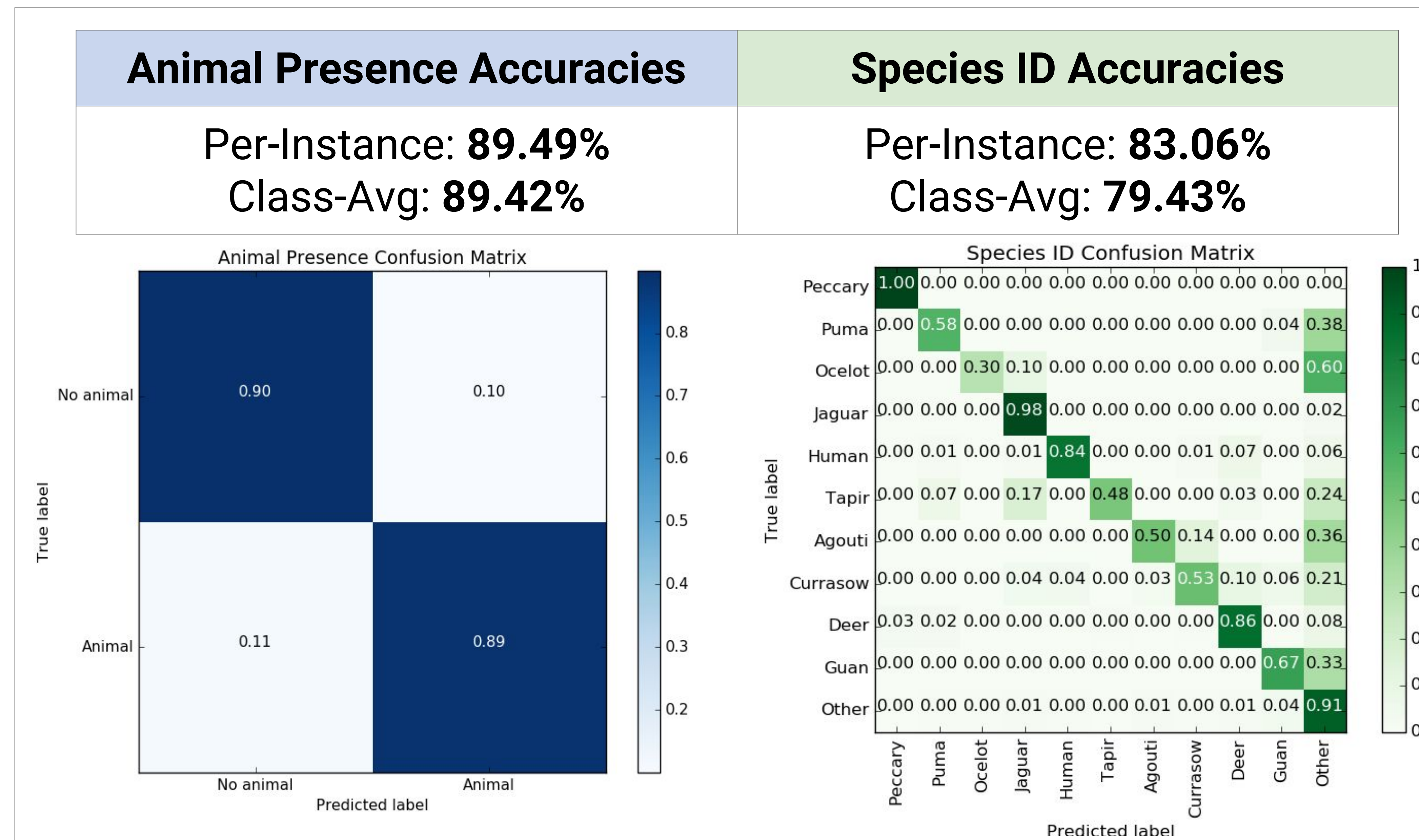
Example images of each species in the camera trap dataset.

### Two Step Classification Pipeline



- For each step in the pipeline:
  - Finetune ImageNet pre-trained CNN model on **camera trap dataset** (based off Inception v3 architecture).
  - Record **per-instance & class-average** accuracies on validation set (class-avg accounts for class imbalance).
  - Observe **confusion matrices**.

### Camera Trap Species Identification Results



### Individual Jaguar Identification

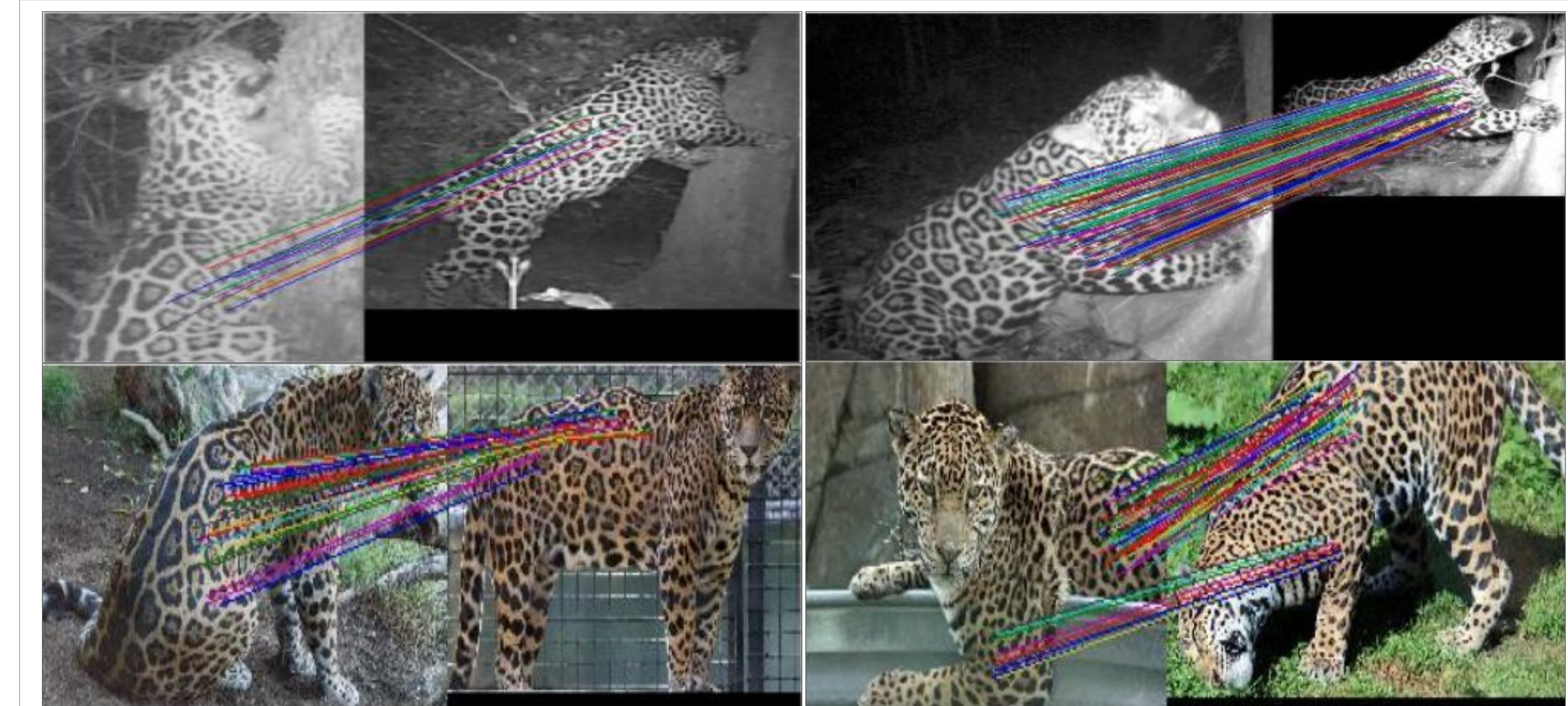
#### JaguarID Dataset

- **176 images of 16 different jaguars** in zoos and the wild, taken from camera traps and Flickr.
- Photos range from **low to high resolution, color and grayscale**, and varying levels of **motion blur**.

#### Methodology

- Detect features from **gradient info (scale, translation, rotation invariant)**.
  - Jaguars can **contort** their bodies in a variety of poses.
- Match features robustly using **SIFT descriptors**.
- Use **RANSAC** to find consistent groups of inlier matches.
- **Leave-one-out evaluation procedure**: find instance in dataset with highest number of inlier matches.

#### Jaguar ID Results



Matched SIFT descriptors across images using RANSAC.  
**91.48% top-1 accuracy** is obtained with our approach.

#### Future Directions

- Extend individual ID to other animals, including ocelots and white-tailed deer.
- Incorporate object detection and pose estimation.

#### Acknowledgements

To the UMass Amherst Department of Environmental Conservation and the Instituto Internacional en Conservación y Manejo de Vida Silvestre, Universidad Nacional, Heredia, Costa Rica, for providing us with the Costa Rica Camera Trap dataset; for the permission and cooperation of Santa Rosa National Park, Guanacaste Conservation Area, Costa Rica; and to our collaborators from Lee Richardson Zoo, Palm Beach Zoo, The Living Desert, Turtle Back Zoo, Sacramento Zoo, and San Diego Zoo Global for providing us with the JaguarID images. The project is funded partly by grants from NSF **1749833** and **1617917**.