Leveraging Drone + AI To Identify Buffelgrass / Invasives Grasses

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Steven Girouard (Drone Master/Pilot)

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A ‘Volunteering’ Collaboration between Intel and The Sonoran McDowell Conservancy

(Intel Circuit Press Article)

Intel Volunteers Core Team Intro

Magdiel Galan has over 30+ years Intel experience in various roles ranging from Autonomous Vehicles, Fab/Sort Yield Engineer, Graphics, IOTG and Supply Chain Data Analyst. Patent holder with a PhD in Computer Science in Machine Learning and Data Mining from Arizona State University. Passionate in STEM and Volunteering.

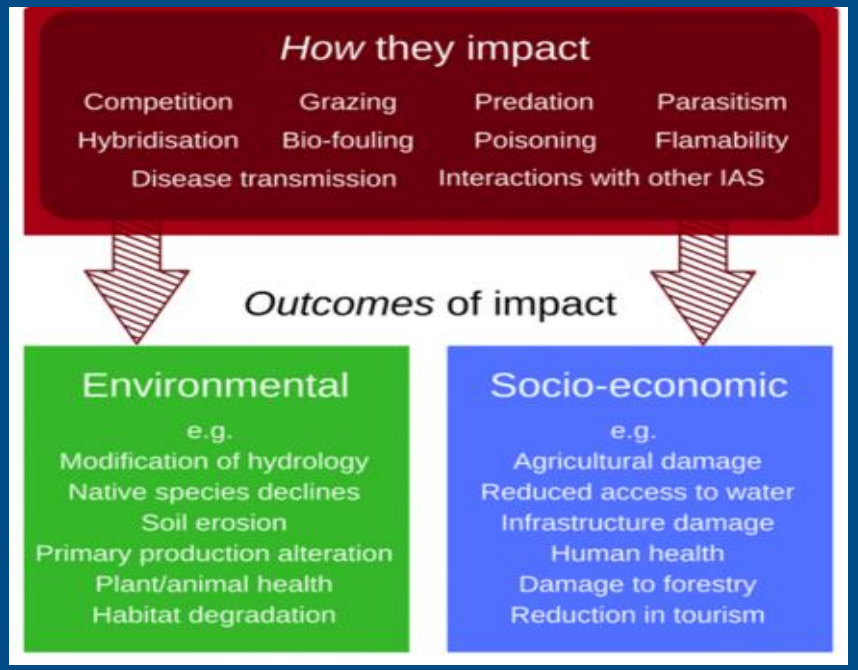
Steven Girouard retired from Intel Corporation after 30 years in reliability engineering and program management with commercial and light show drones being the highlight of his career. He is now working as a consultant with multiple robotic and drone companies focusing on technology development and inspection and mapping services.

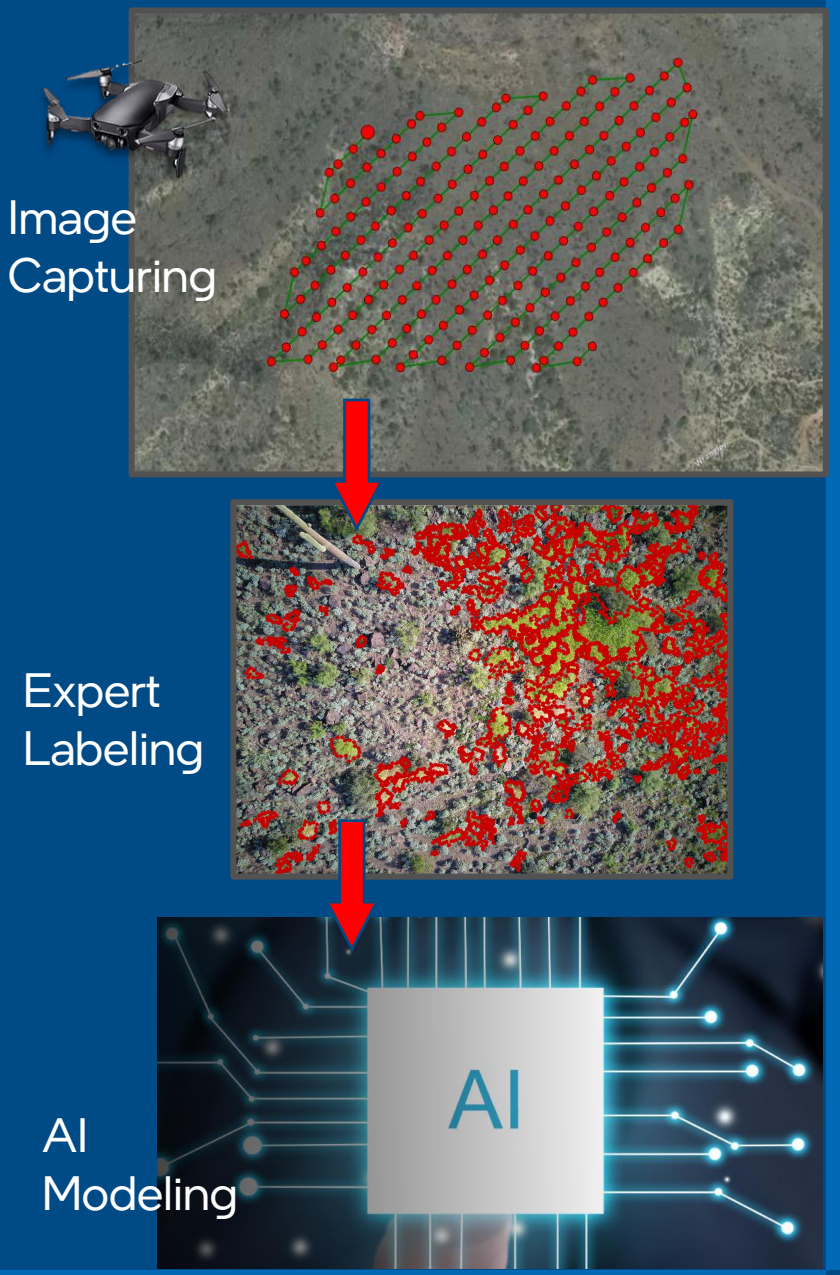
Jacob Krakauer is a Systems/Mechanical engineer for the Automotive Solutions Group. Works with government/educational groups and supports Autonomous Vehicles reference designs. Main focus is educating public and academic worlds of industry innovations and developing automotive robust systems. Drone enthusiast and pilot.

Neethu Elizabeth Simon is an IOT/AI/ML Sr. Software Engineer solutions ‘lead’ in retail healthcare and others. An IEEE Senior Member and ASU Computer Science graduate. Passionate about sharing/volunteering for advancement of women in STEM. Speaker at IEEE & SWE conferences and recipient of 2023’s Women Who Code and 2020 SWE’s Distinguished New Engineer Awards for leadership, industry innovation & STEM advocacy.

Our Project:

Use Drone imagery in desert regions to identify fire-prone invasive grasses using AI in effort to minimize/prevent wildfires.





Current Approach

Stewards & Volunteers

Terrain Survey

Prevention/Removal

Issues:

- Difficult estimate need of volunteers and equipment
- Harsh/hazardous terrain aggravates access/identification of invasive species

Strategy:

- Visual inspection → hike a fraction of ~ 30,000 acres
- Educated guesses in quest to find invasive grasses

Challenges:

- Volunteers carry herbicides to locale to spray while negotiating harsh terrain
- More labor required to remove grownup grass

Proposed Approach

- Visual Inspection → Aerial Imaging with Drone
  - Dramatically increases coverage, efficiency, and safety.
    → *The quicker invasive grasses removed, less chances for it to spread*

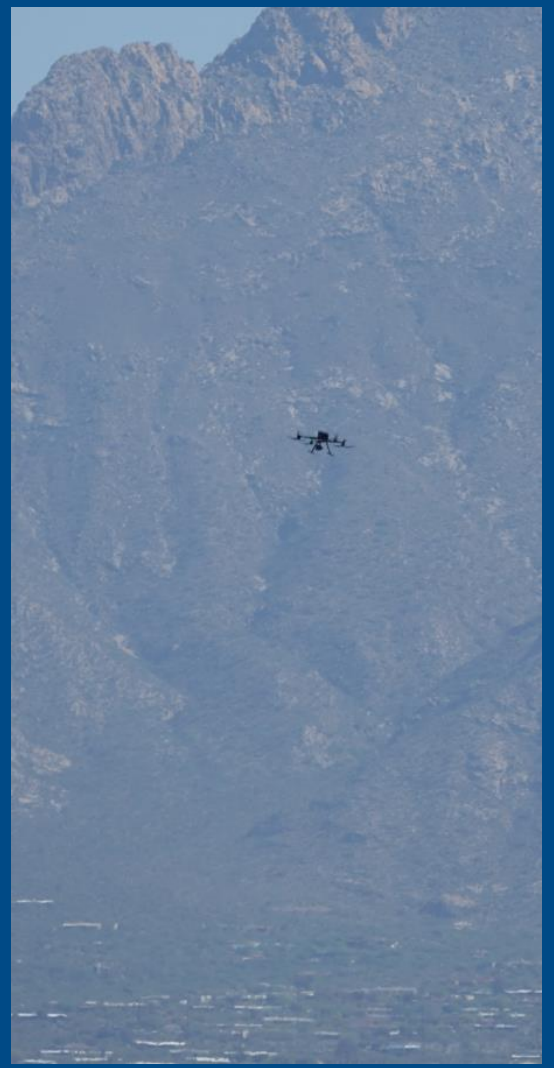
- Develop a 'grasses' detection/identification using AI from drone imaging
    → *like face-recognition, but for grasses*
        → *Intel Seed Grant from Intel Foundation*

How did we make it to Tumamoc…?

- Collaboration between:
  - McDowell Conservancy
  - Northern Arizona University
  - University of Arizona

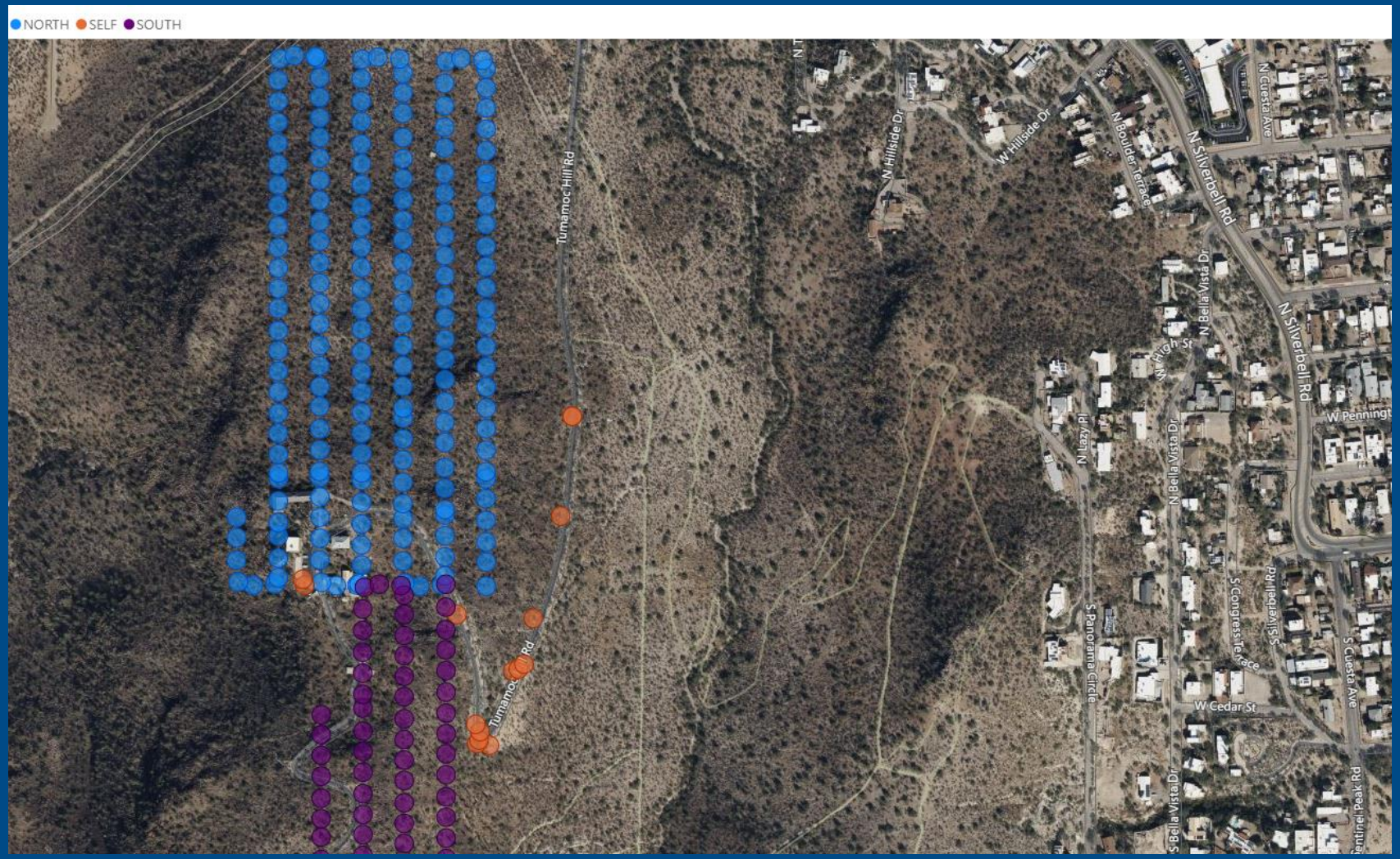
‘Droning’ @ Tumamoc Hill

Tumamoc Hill

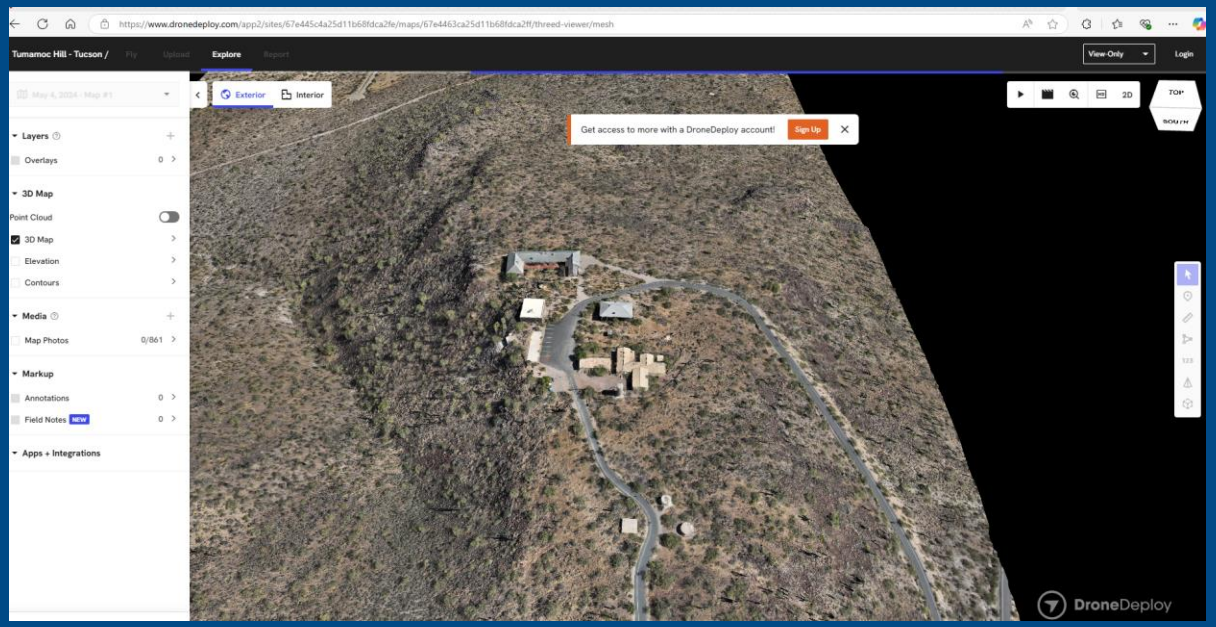


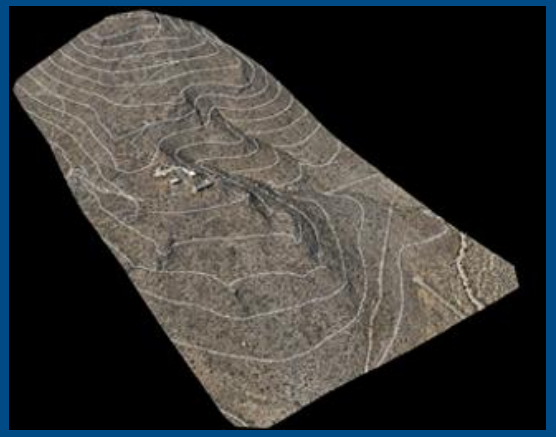
LAUNCH Demo

Tumamoc Hill Drone Mapping



Tumamoc Hill DroneDeploy

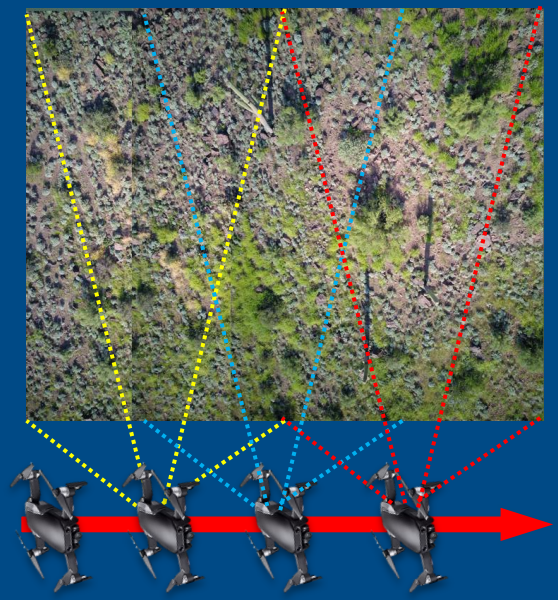




DroneDeploy @ Tumamoc Hill

AI Approach/Development

Drone Image Capture

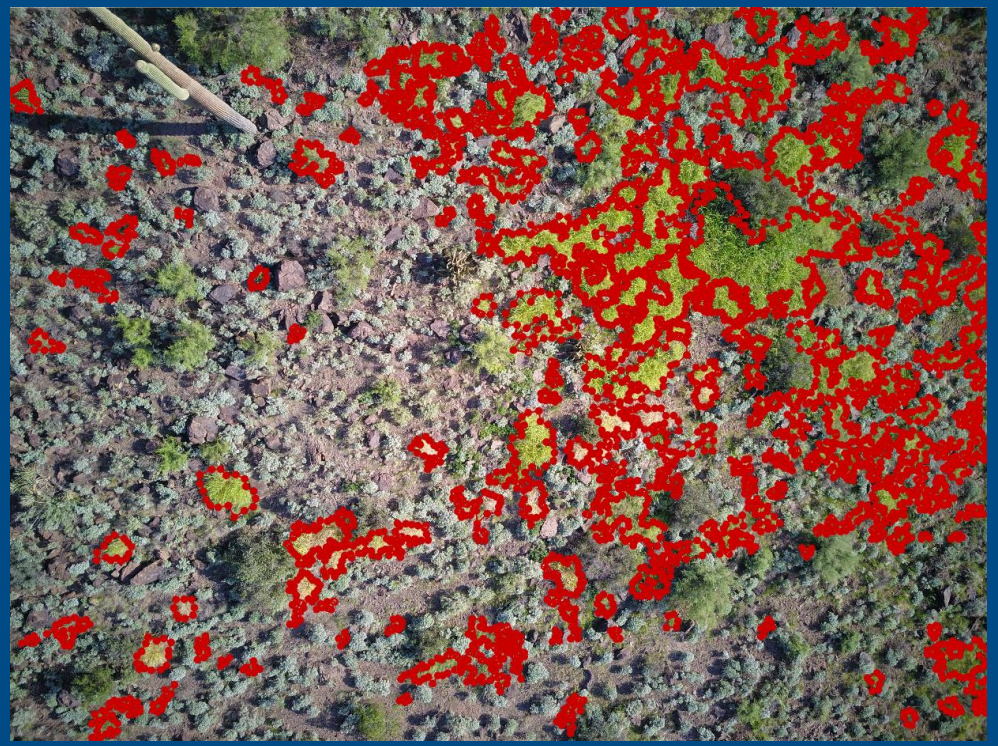


OBSERVE:

- Overlapping Sweep
- Change in Perspective

Conservancy Experts & Botanist Labeling

Captured



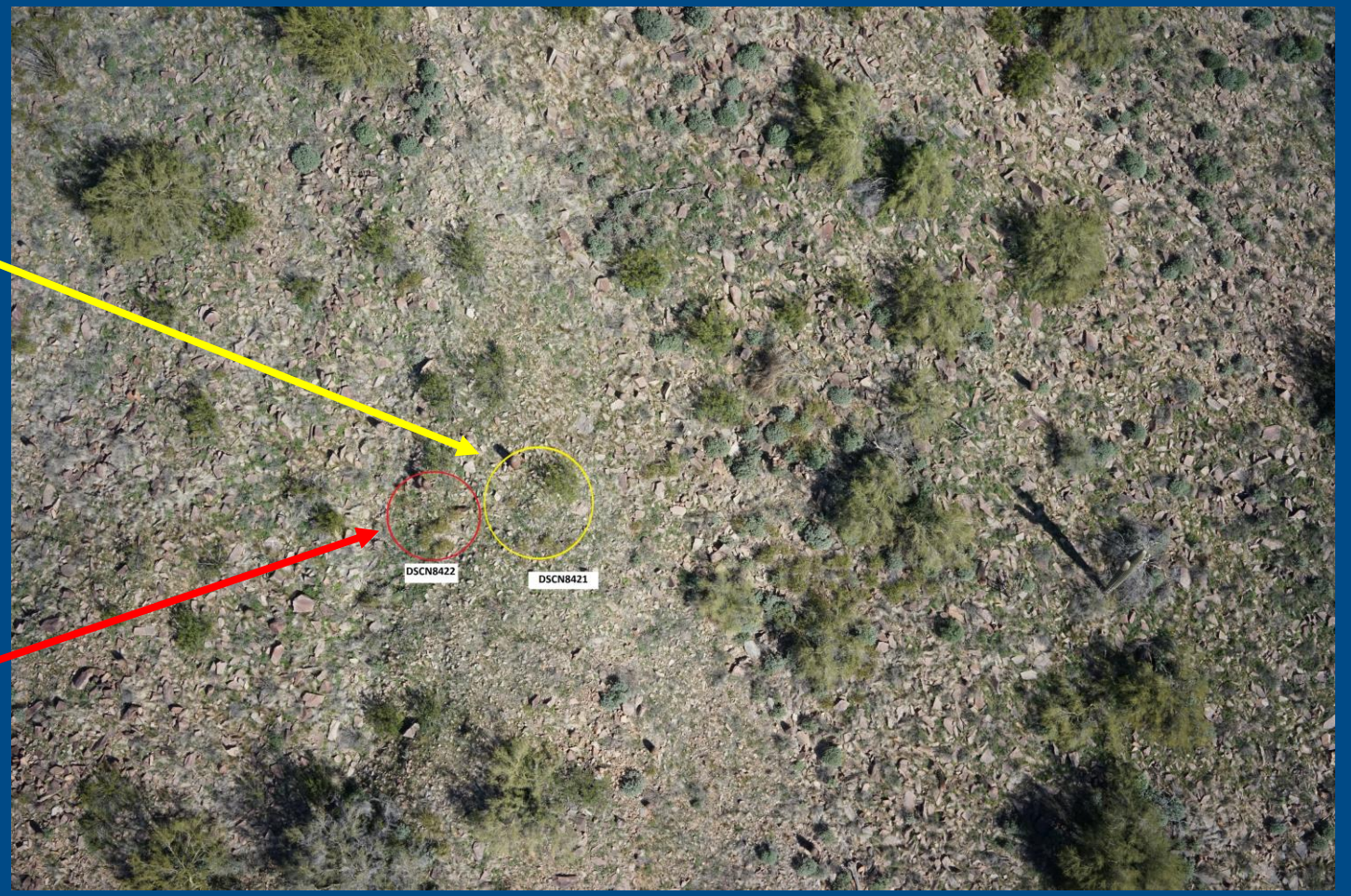
Labeled

Drone vs. Ground @ Tumamoc

Ground View

ZOOM from Above

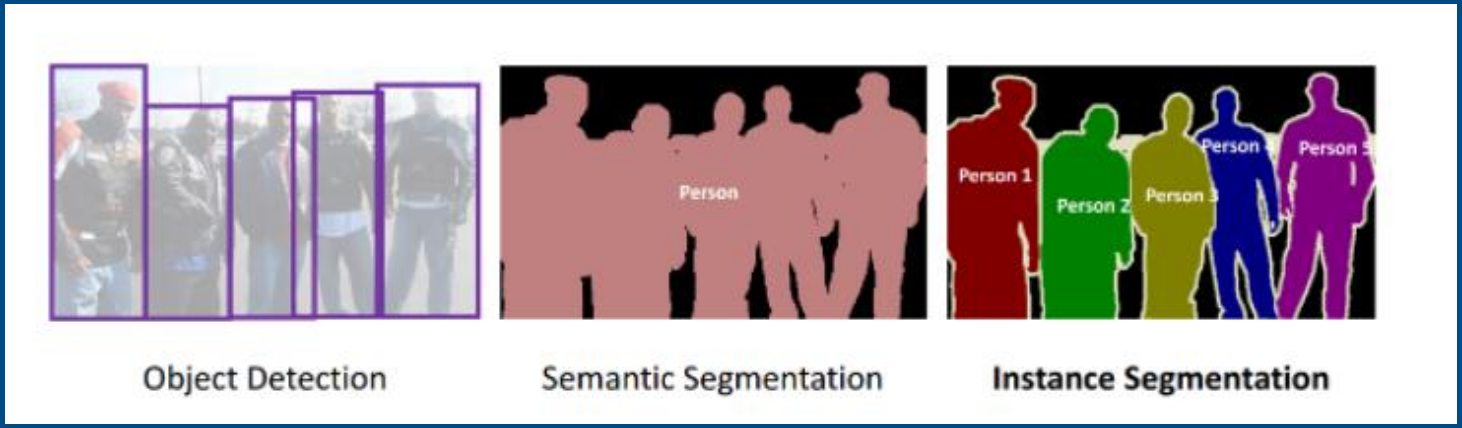
Ground vs. Drone @ McDowell

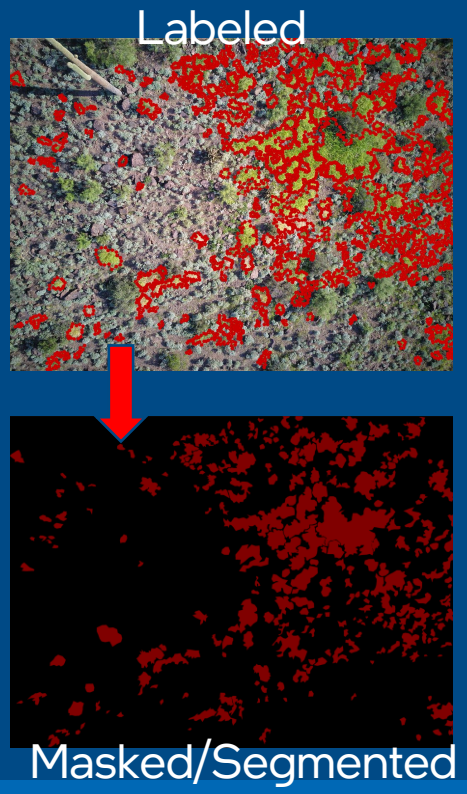


33.605525, -111.8373861

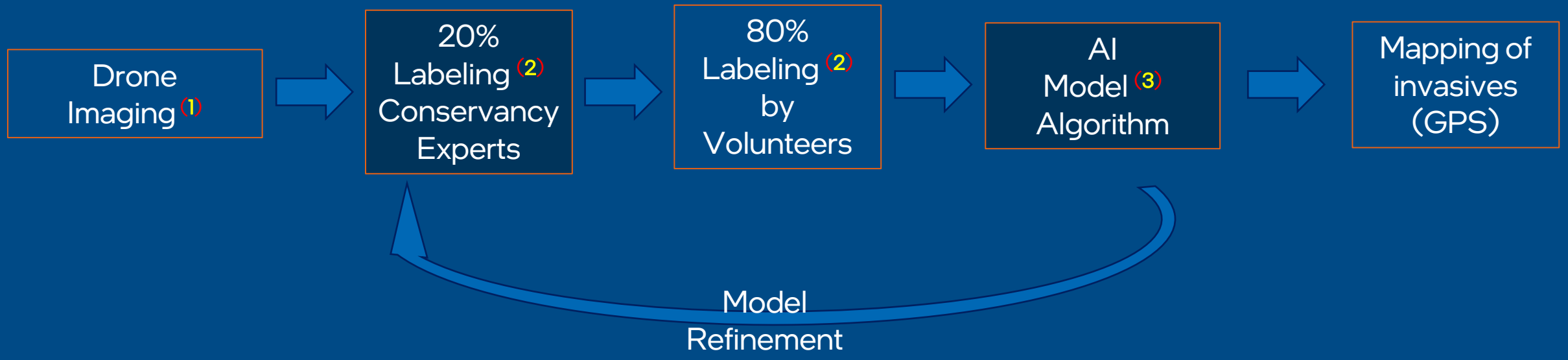
AI Modeling Process & Challenges

- Deep Learning Neural Network
  - Developed for Biology, successfully applied to vegetation
  - Segmentation: segment into class areas/groups
    - Semantic: Buffelgrass
    - Instance: Buffelgrass #1, Buffelgrass #2, etc.
  - Challenges:
    - Lighting Conditions
    - Seasonal





Process, Roles & Collaboration



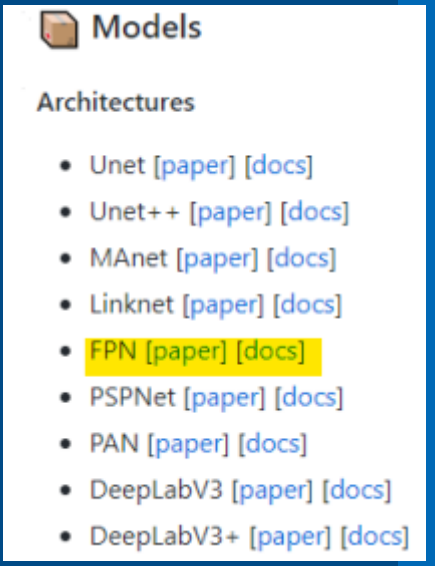
(1) Altitude: 70m AGL (above ground level) → 0.98 cm/pixel
(2) Annotation Tool
(3) Semantic Segmentation

AI Modeling Process & Challenges

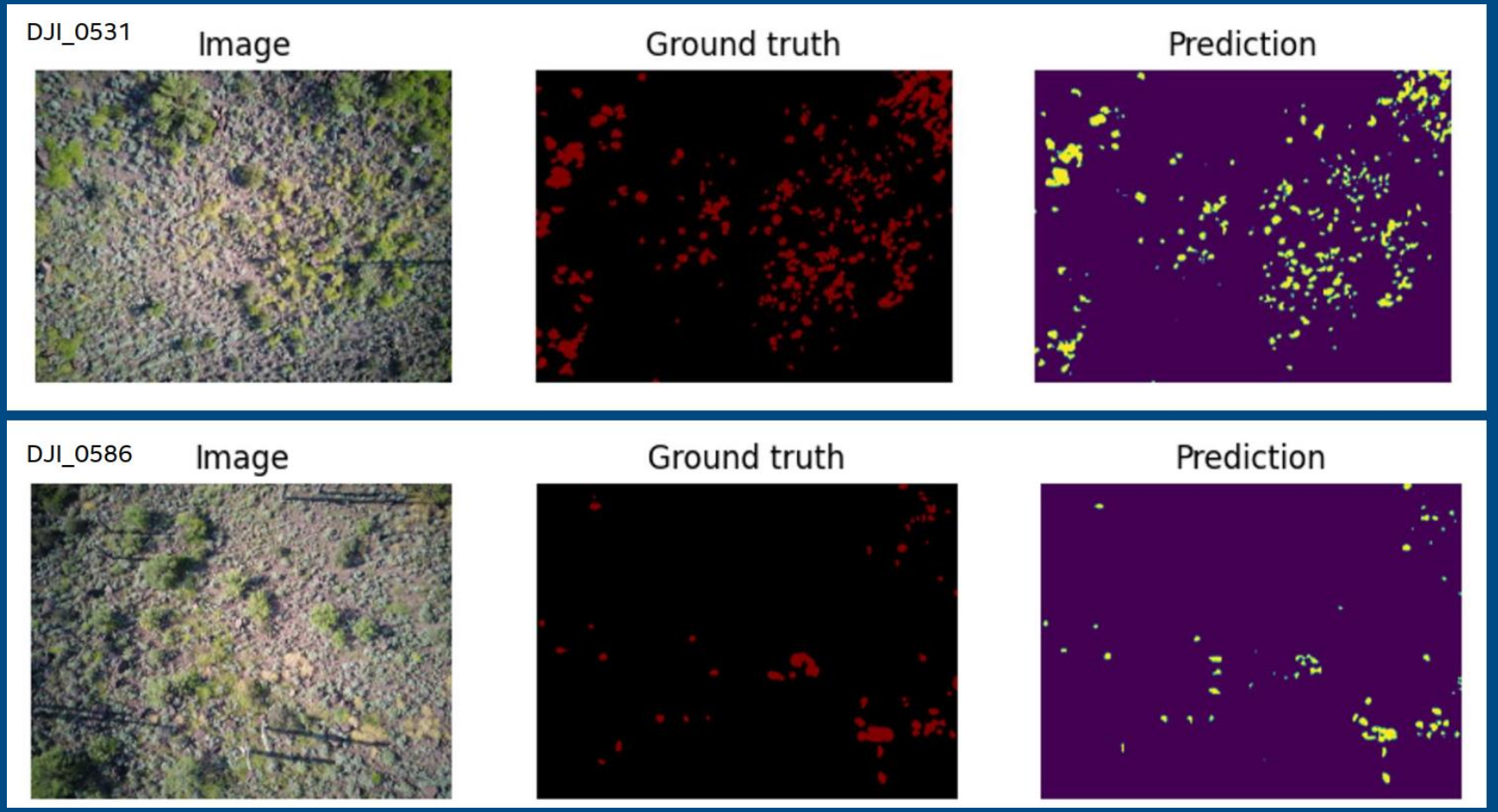
- Reference PyTorch Segmentation repo:
  - https://github.com/qubvel/segmentation_models.pytorch
- Github:
  - https://github.com/intel-sandbox/sonoran_conservancy (Intel internal)

- Dataset: Brown's Ranch Trail 8-29-2021 Buffel Grass
  - Green buffel grass
- Labels: McDowells Conservancy Labeled (61 count)

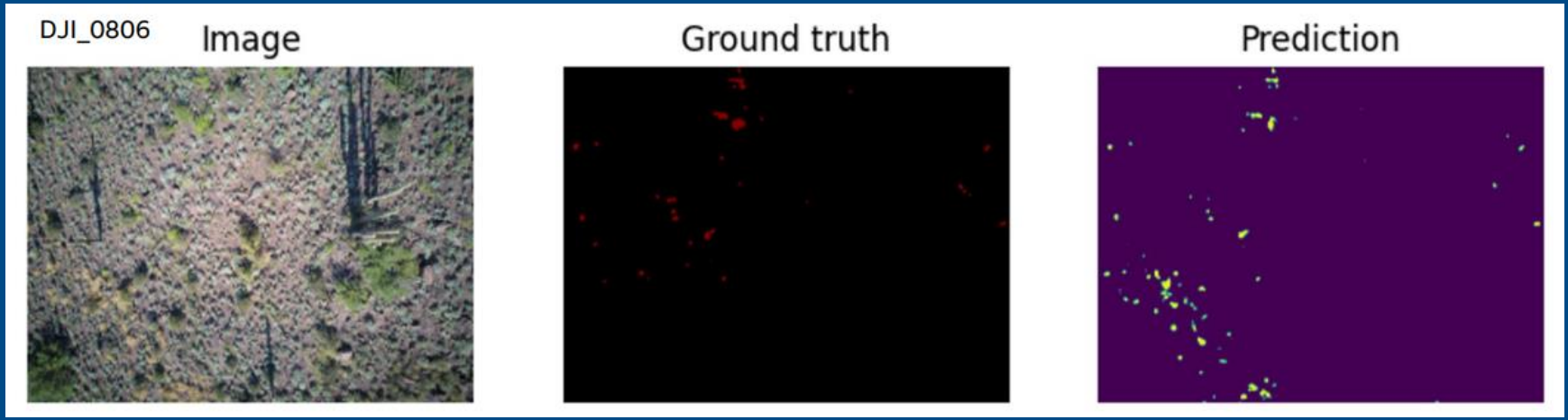
- Initial training:
  - Train/val/test split : 80:10:10 (=> image count: 48/6/7)
  - Sliding window crop: 400x400
  - Model: FPN, Encoder: resnet34 (ImageNet weights), input: 256x256



Baseline AI Preliminary Results



Baseline AI Preliminary Results



'*dataset_iou*' means that we aggregate intersection and union over whole dataset and then compute IoU score. The difference between '*dataset_iou*' and '*per_image_iou*' scores in the case of a dataset with 'empty' images (images without the target class) a large gap could be observed. Empty images influence a lot on '*per_image_iou*' and much less on '*dataset_iou*'

Prelim Results

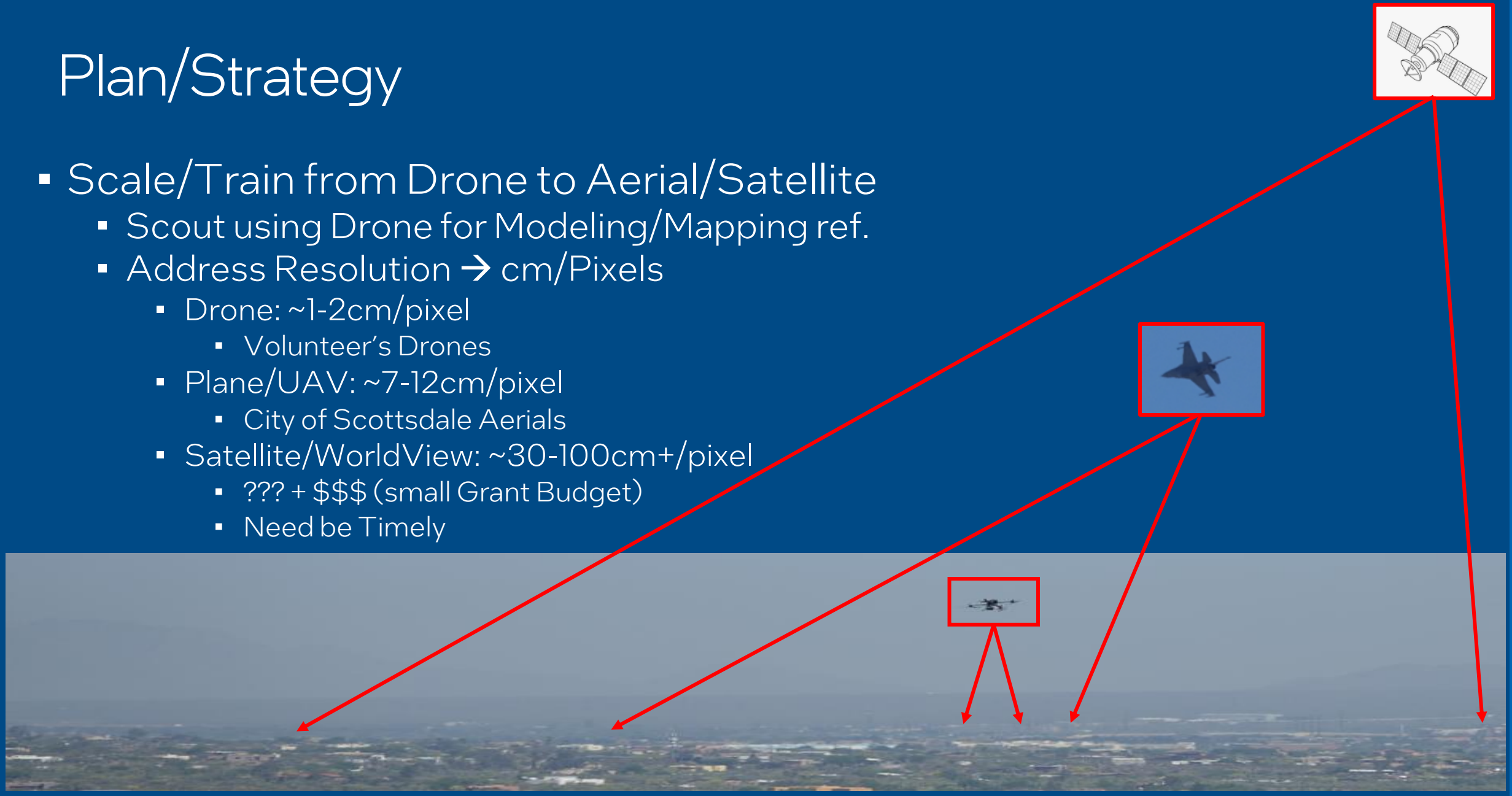
```
LOCAL_RANK: 0 - CUDA_VISIBLE_DEVICES: [0,1]

                                                                        [
{'valid_dataset_iou': 0.6118319034576416,
 'valid_per_image_iou': 0.7643078565597534}]
LOCAL_RANK: 0 - CUDA_VISIBLE_DEVICES: [0,1]
Testing: 100%|                                                          | 31/31 [00:01<00:00, 19.39it/s]
[{'test_dataset_iou': 0.5771934390068054,
 'test_per_image_iou': 0.7104794383049011}]
```

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$

Plan/Strategy

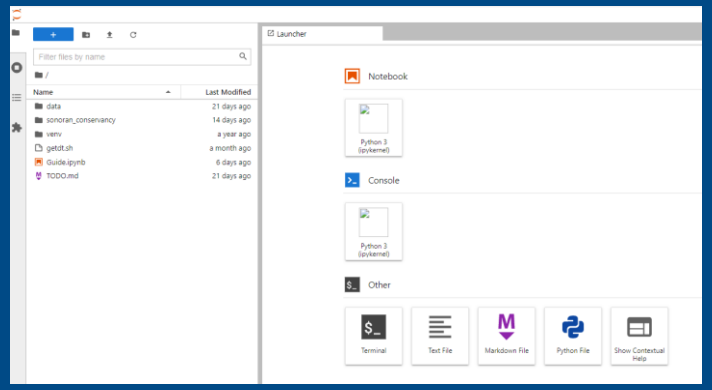
- Scale/Train from Drone to Aerial/Satellite
  - Scout using Drone for Modeling/Mapping ref.
  - Address Resolution → cm/Pixels
    - Drone: ~1-2cm/pixel
      - Volunteer's Drones
    - Plane/UAV: ~7-12cm/pixel
      - City of Scottsdale Aerials
    - Satellite/WorldView: ~30-100cm+/pixel
      - ??? + $$$ (small Grant Budget)
      - Need be Timely

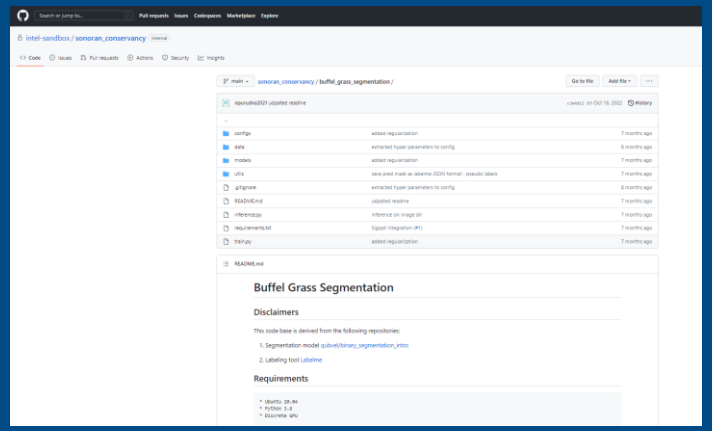


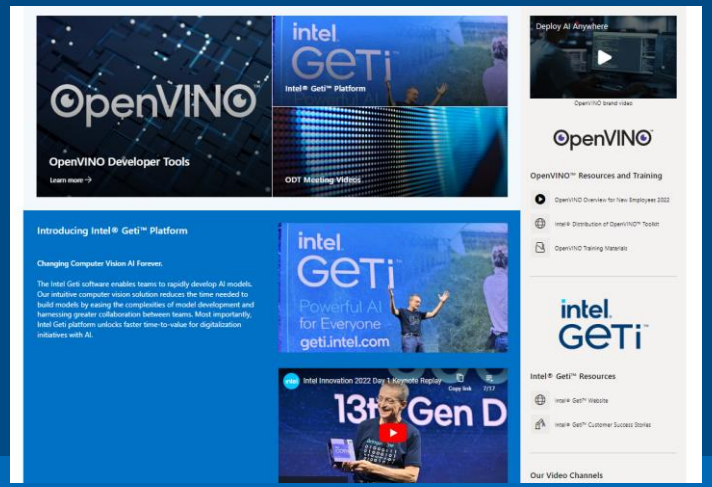
AI → 2-Tier Approach

- Self Contained
  - Conservancy Manages own Hardware
  - GPU Capable System
  - Jupyter Notebooks
  - GIT Repository

- AI as a Service:
  - Intel's GETI Environment
    - AI Anywhere
  - Rapid AI Deployment







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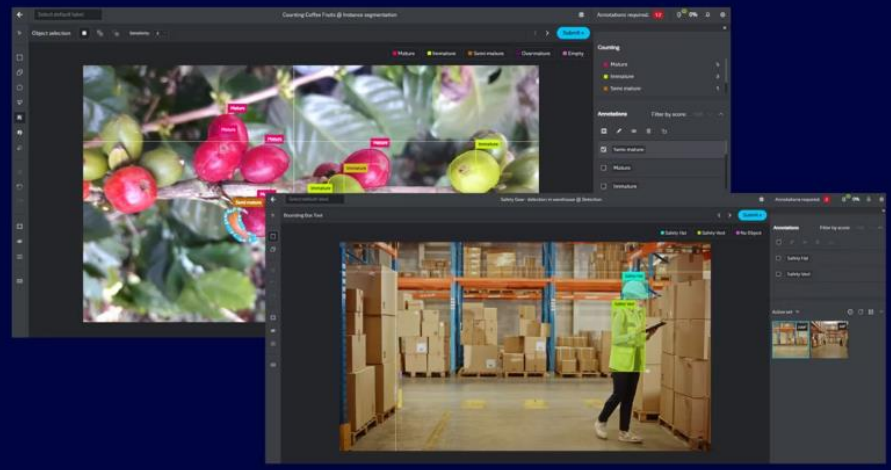

AI-Project Maintenance

- Intel Internal Project Maintenance
  - GitHub Repo - https://github.com/intelsandbox/sonoran_conservancy
  - Internal Training Systems

- Maintenance Challenges –
  - Inaccessible to Non-Intel Volunteers
  - Dependency on Maintainers - system needed to be re-started frequently
  - Resource constraints (CPU/GPU/Memory)

AI-Project Maintenance

- Semi - Open-Source Approach
  - GitHub Repo
    - Private Repo - https://github.com/NeethuES-intel/sonoran_conservancy
    - Need-based Access
  - Kaggle Training Systems
    - Need-based Access to Project
    - Extendable Resources (paid-options available)

Open-Source Approach – Access-Controlled


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