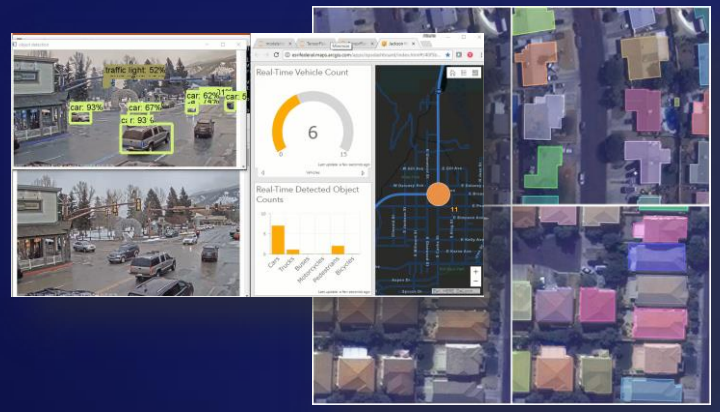
Deep Learning for Tree Counting and Building Extraction

Yoga Abdilah

June 11th, 2020

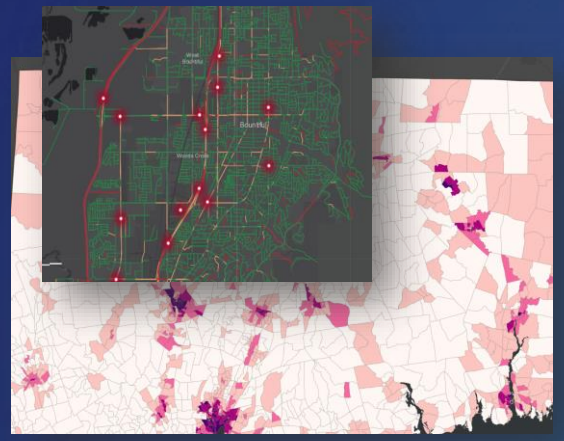
GeoAI Pattern

Object Detection



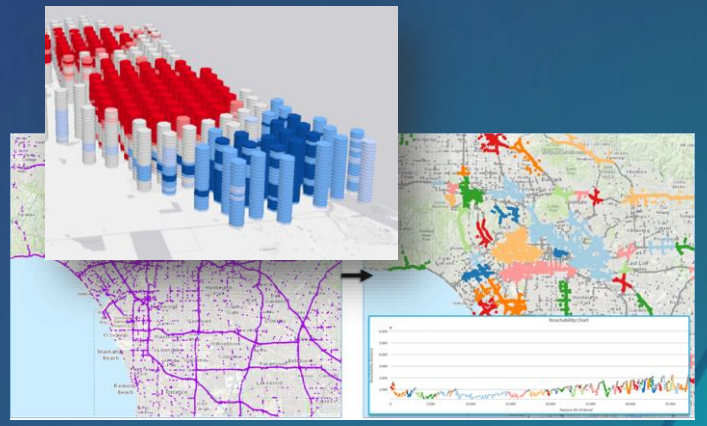
Buildings, Road Segments, Swimming Pools, Blight, Graffiti, Overgrowth, Road Signs, Vehicles from CCTVs, and more

Prediction



Water Pipe Breaks, Diseases, Crimes, Crashes, Incidents, Fires, Congestion, 911 Calls,

Pattern Detection



Top Risky Segments, Emerging Hotspots of 911 Calls, Disease Clusters, and more

Examples for Imagery AI Workflows

Object Detection, Instance Segmentation, Land Cover, Change Detection..

Tree Counting

Building Footprints

Land Cover

Pipeline Encroachment

Swimming Pools

Roads

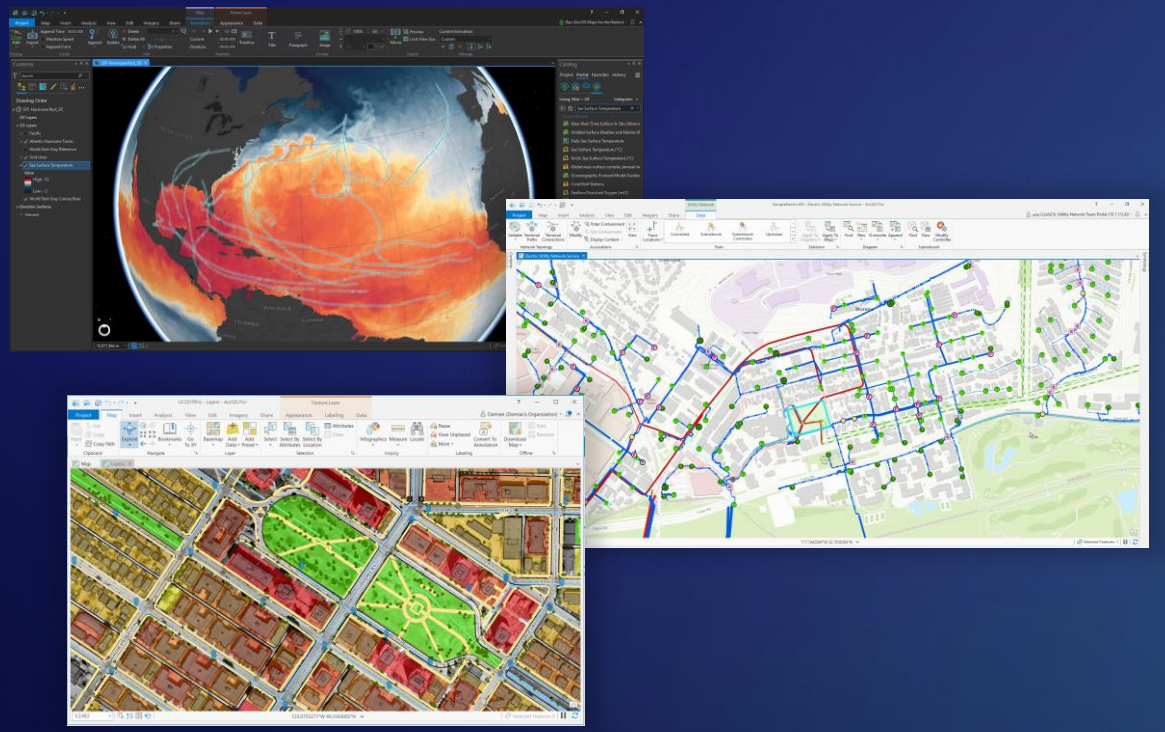
Oil Pads

Road Cracks

Cars

Damaged Structures

ArcGIS Pro Professional GIS



Advanced Mapping, Visualization, Editing and Analysis

Improvements

- Utility Management
- Faster Startup
- Editing Tools
- Catalog Preview
- Definition Expressions
- Contingent Attributes

New

- Reports
- Dimensions
- Spell Check
- Publish to Server
- Deep Learning
- Parcel Management

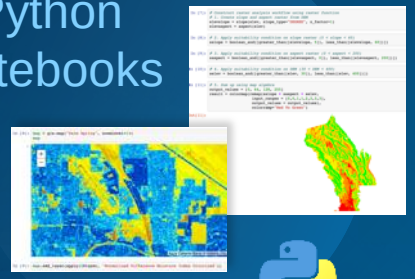
Coming

- Offset Printing
- More Parallel Processing
- Voxel Support

Integrating Open Science, AI and Machine Learning

Revolutionizing Spatial Analysis and Data Science

Python Notebooks



Analytic Services

Python API

Integration

AI & Machine Learning

Open Science Tools

Big Data GeoAnalytics

Spatial Analysis & Geoprocessing

Geospatial Infrastructure

Open Science

CONDA

dmlc XGBoost

jupyter

Keras

matplotlib

OpenCV

pandas

scikit learn

SciPy

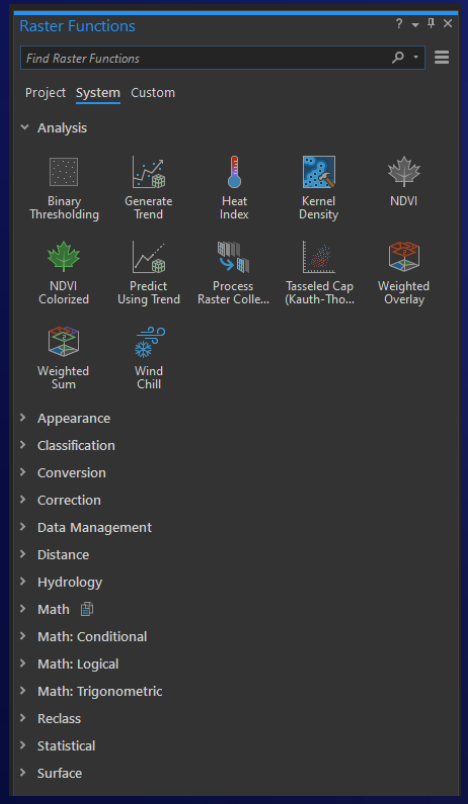
SymPy

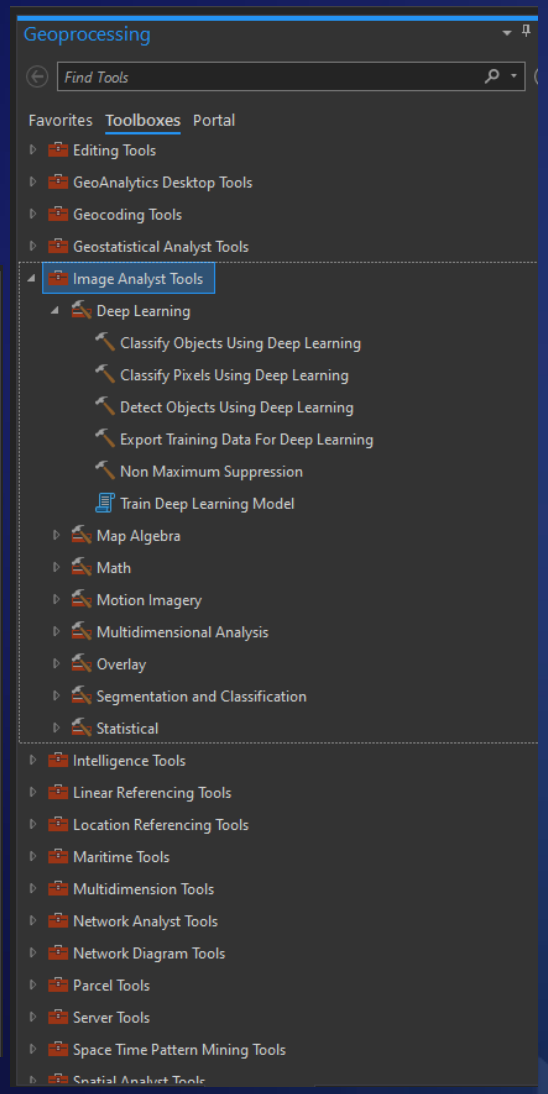
TensorFlow

PYTORCH

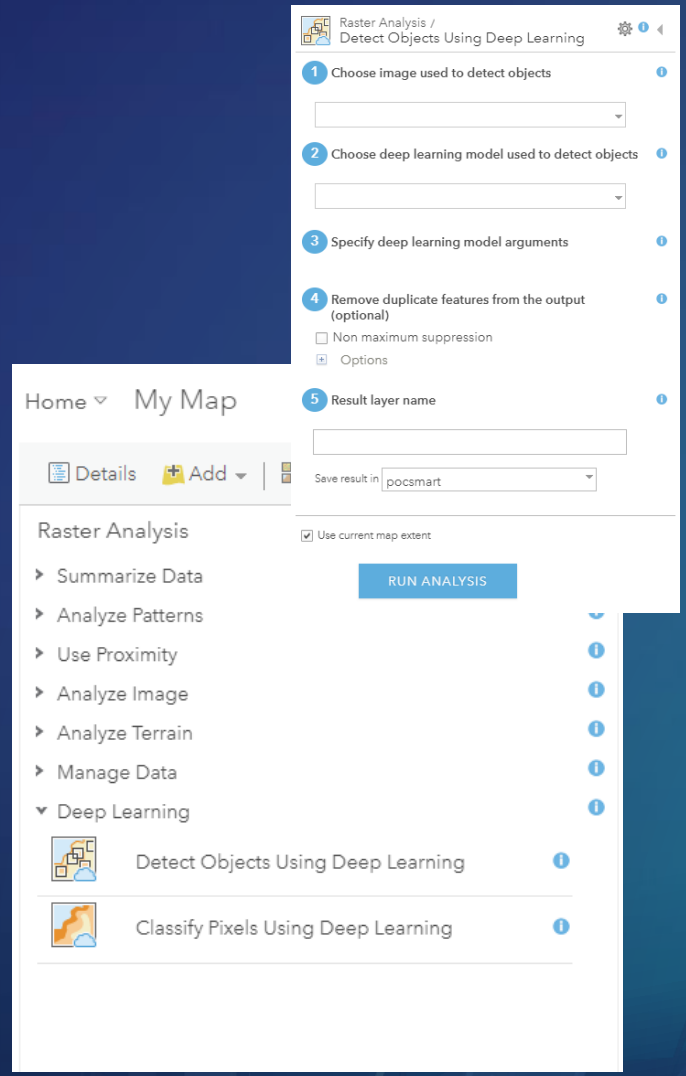
GeoAI User Experience

Pro





Web



Python API

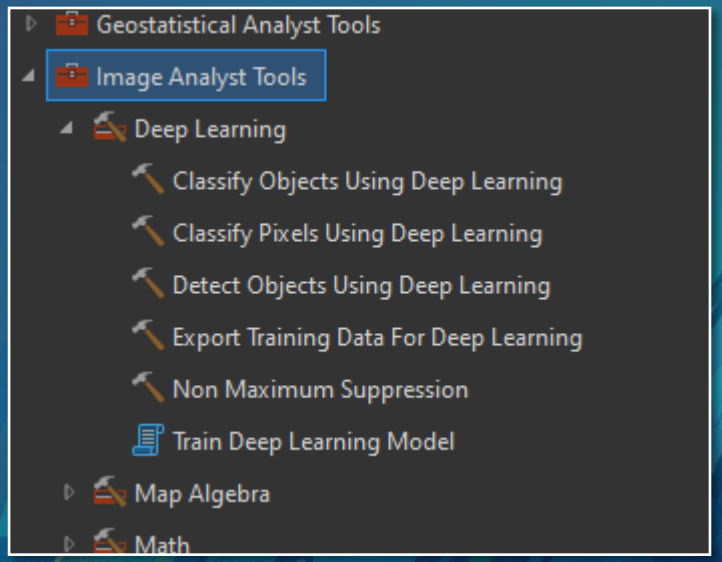
Tree Counting

With Deep Learning in ArcGIS Pro

Tree Counting

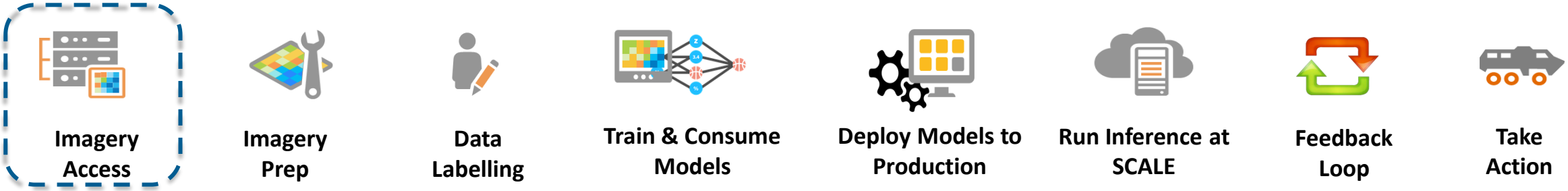
with Deep Learning in ArcGIS Pro

- Only available in ArcGIS Pro.
- Require Image Analyst extension.
- Object detection workflow first introduced in ArcGIS Pro 2.3
- Begin with installing deep learning frameworks for ArcGIS.



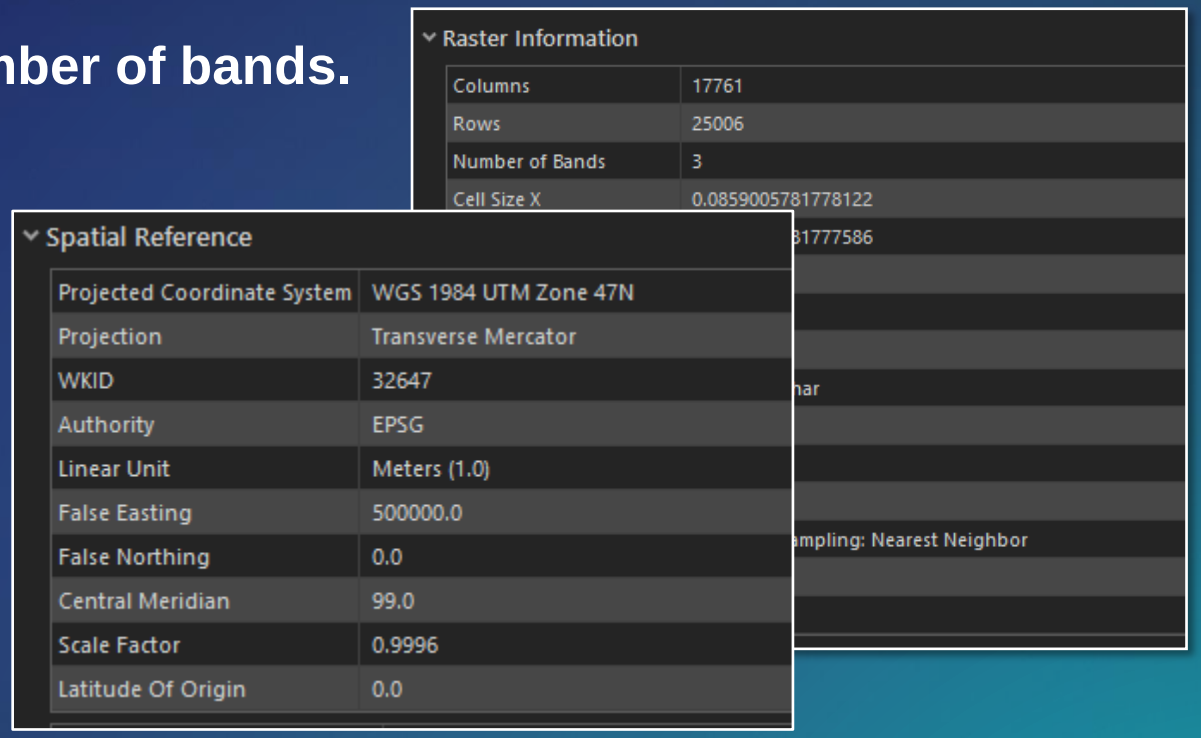
End to End Tree Counting Workflow

- Identify how we access imagery data.
  - Raster file?
  - Mosaic Dataset?
  - Mosaic Dataset in a shared directory/datacenter?



End to End Tree Counting Workflow

- Identify image format, spatial reference, number of bands.
- Specify processing extent.



Imagery Access

Imagery Prep

Data Labelling

Train & Consume Models

Deploy Models to Production

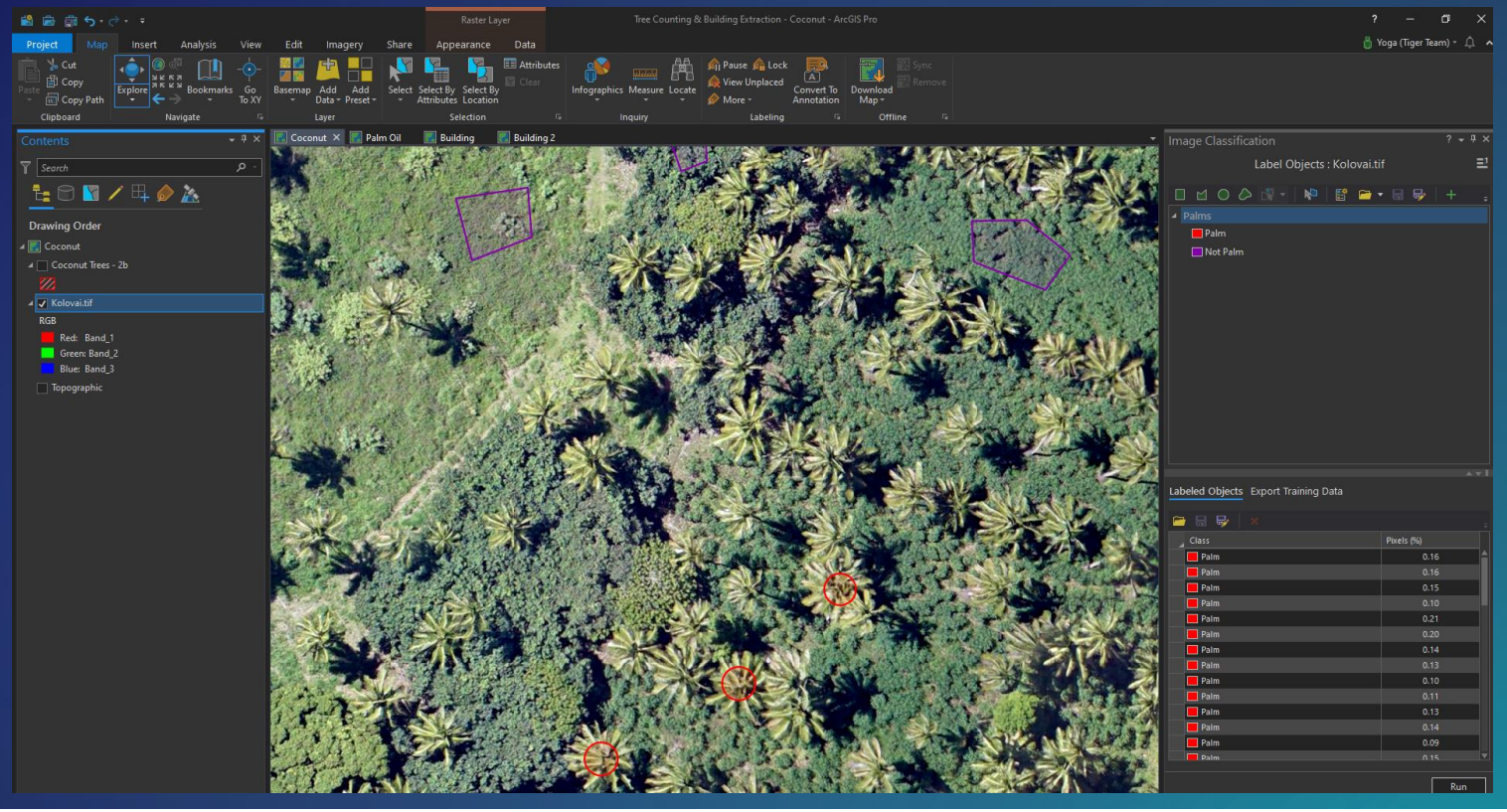
Run Inference at SCALE

Feedback Loop

Take Action

End to End Tree Counting Workflow

- Create training samples.
- Number of samples might vary
  - Method used
  - Image size



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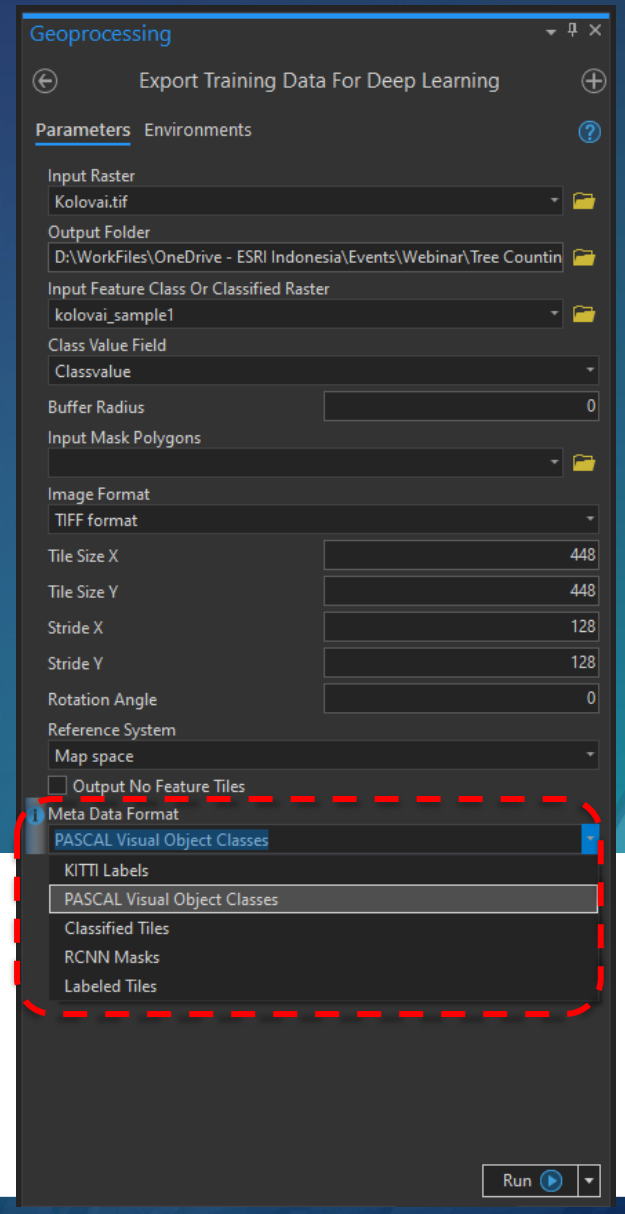
End to End Tree Counting Workflow

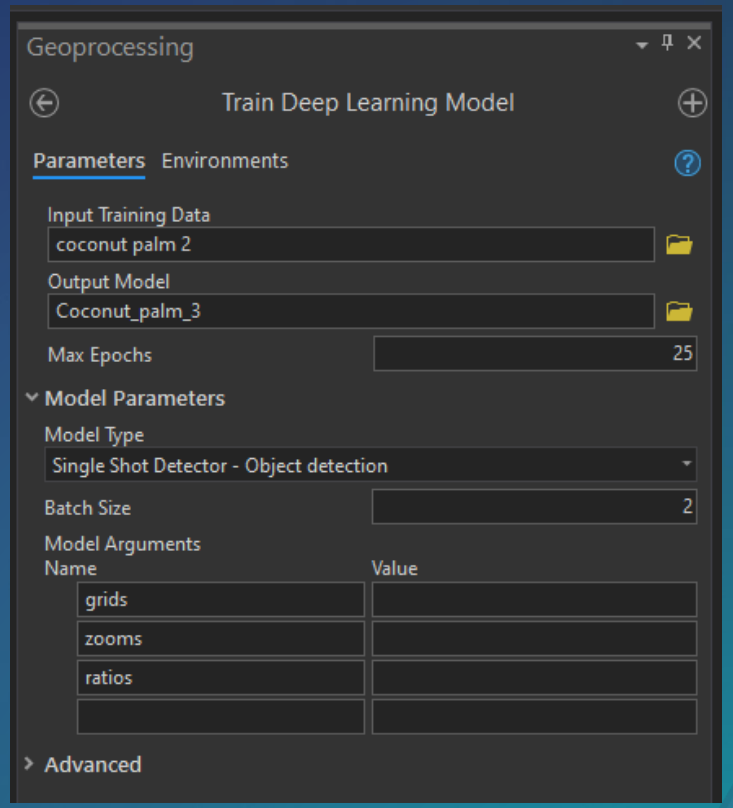
- **Start by Exporting data**
  - **GP Toolbox: Export Training Data for Deep Learning**



Imagery Access | **Imagery Prep** | **Data Labelling** | **Train & Consume Models** | **Deploy Models to Production** | **Run Inference at SCALE**

End to End Tree Counting Workflow

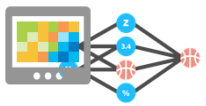
- **Next: Train a deep learning model!**
  - **Using ArcGIS Pro (since 2.5)**



Imagery Access

Imagery Prep

Data Labelling



Train & Consume Models

Deploy Models to Production

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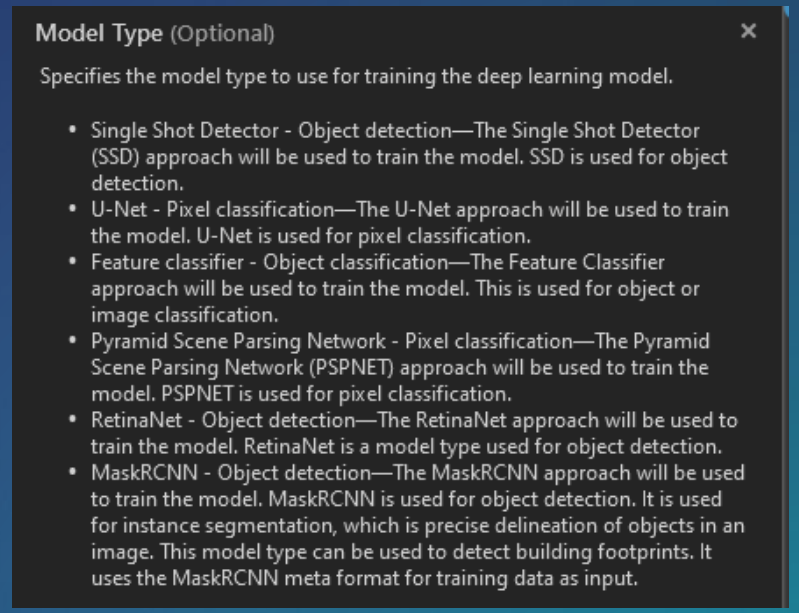
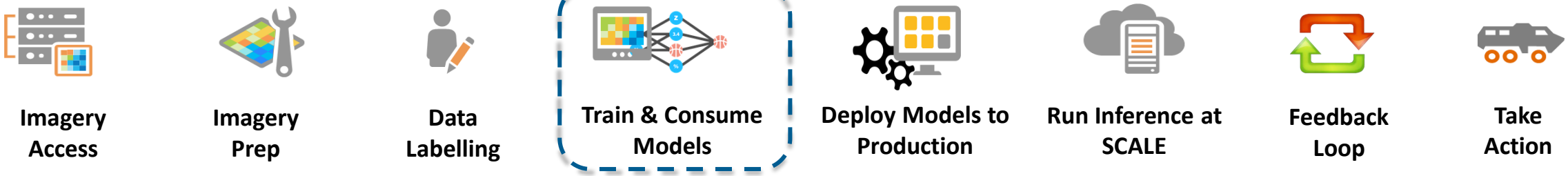
End to End Tree Counting Workflow

- **Next: Train a deep learning model!**
  - **Using ArcGIS Pro (since 2.5)**
    - **Single Shot Detector**
    - **U-Net**
    - **PSPNET**
    - **RetinaNet**
    - **MaskRCNN**





Tree Counting

Image Classification vs Object Detection

Image Classification

Predict object in an image

Object Detection

Predict object in an image
+
Location of the image (bounding boxes)

Tree Counting

Method – Single Shot Detector (SSD)

- SSD divides the image using a grid
- Each grid cell be responsible for detecting objects
  - Probability that there is an object?
  - Height of the bounding box?
  - Width of the bounding box?
  - Horizontal coordinate of the center point of the bounding box?
  - Vertical coordinate of the center point of the bounding box?

Anchor box

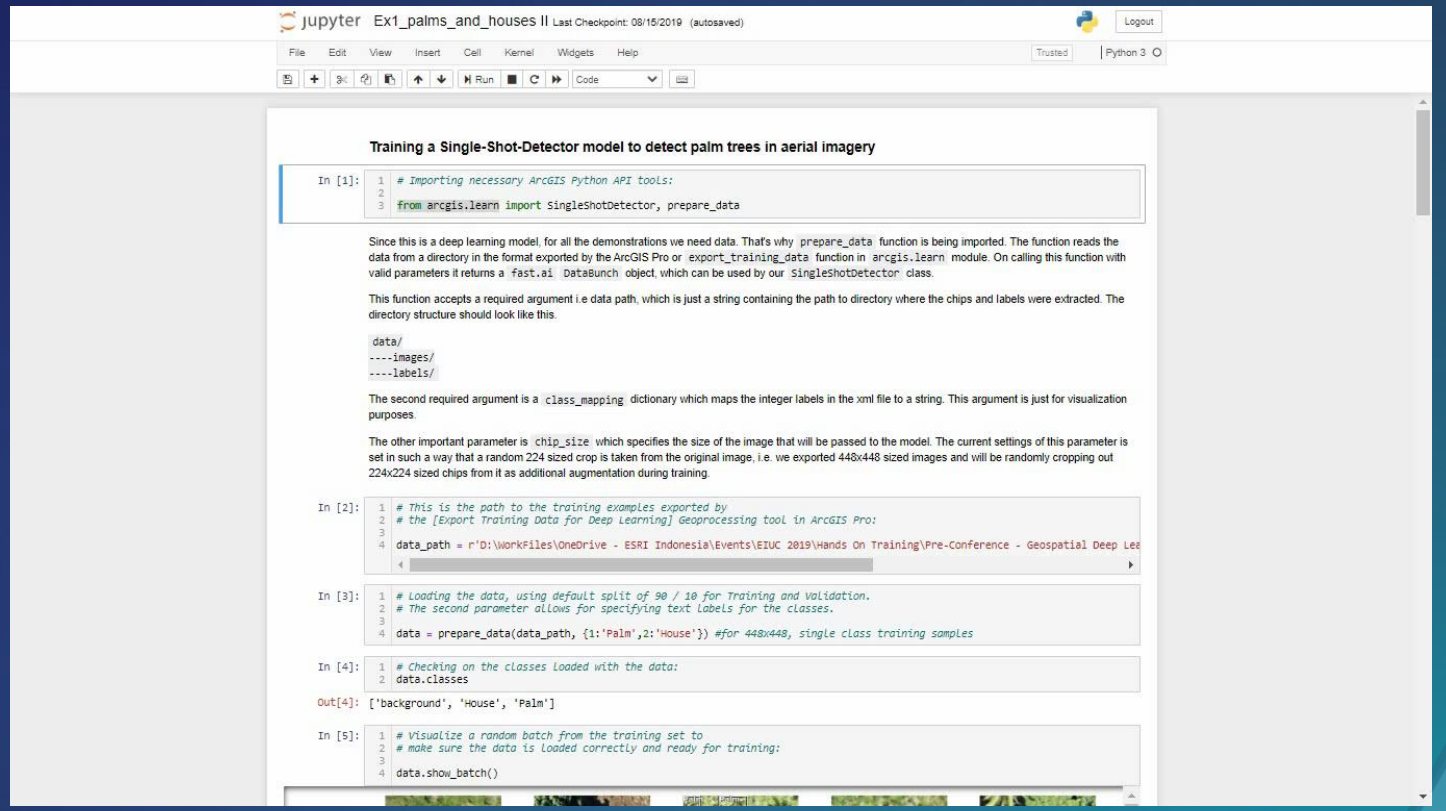
Zoom level

Aspect ratio

https://developers.arcgis.com/python/guide/how-ssd-works/

End to End Tree Counting Workflow

- **Next: Train a deep learning model!**
  - **Using ArcGIS Pro (since 2.5)**
  - **Using arcgis.learn (ArcGIS API for Python)**
  - **Using open libraries**



Imagery Access

Imagery Prep

Data Labelling

Train & Consume Models

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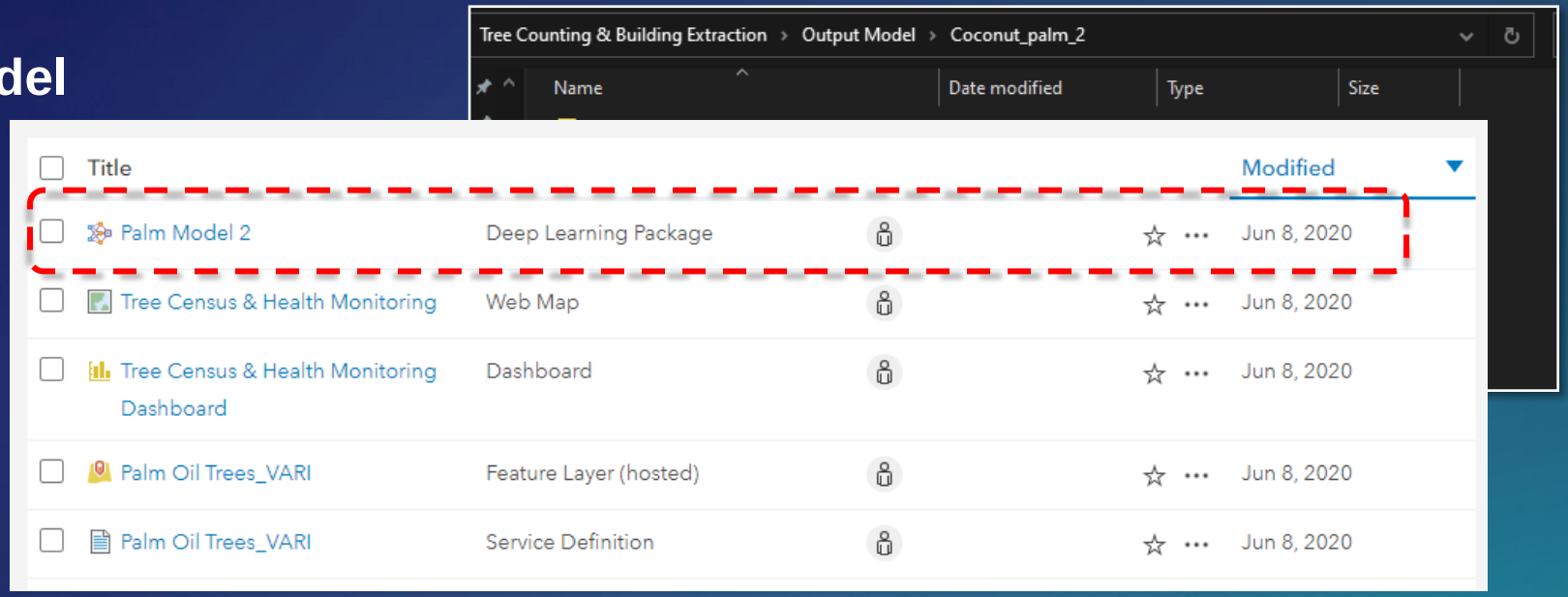
Take Action

End to End Tree Counting Workflow

- **Deploy Deep Learning model**
  - **Accessible also as emd or**
    Deep Learning Package



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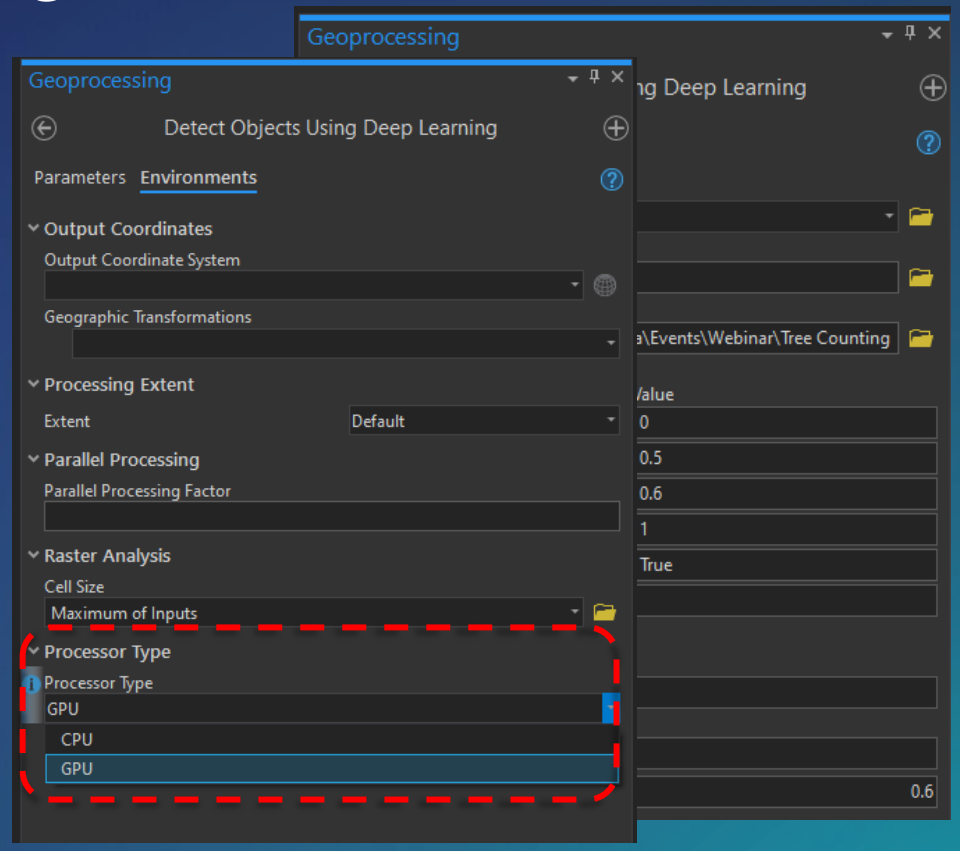
Take Action

End to End Tree Counting Workflow

- **Deploy model & start object detection**
  - **GP Toolbox: Detect Objects Using Deep Learning**



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End to End Tree Counting Workflow

- QC
- Utilize Result:
  - Tree Health Monitoring

Imagery Access

Imagery Prep

Data Labelling

Train & Consume Models

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Feedback Loop

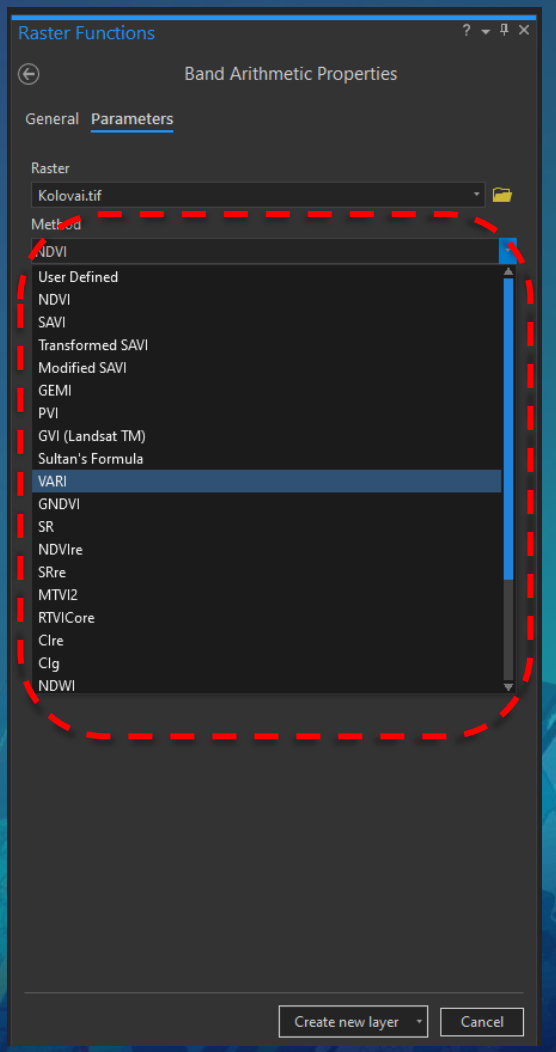
Take Action

Tree Health Monitoring

- Assessing vegetation health using **Visible Atmospherically Resistant Index (VARI)**
  - Indirect measure of leaf area index (LAI) and vegetation fraction (VF)
  - Using reflectance values from the visible wavelength

$$(R_g - R_r) / (R_g + R_r - R(R_g - R_b))$$

  - **Preferred** to use both visible and near infrared (NIR) wavelength



Demo

Tree Counting

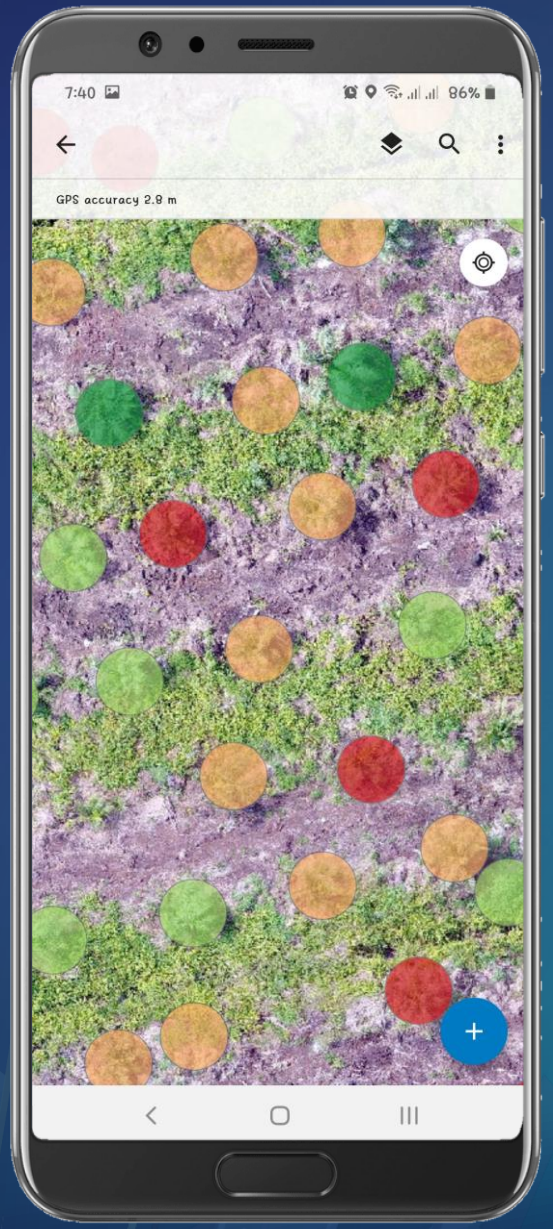
with Deep Learning in ArcGIS Pro

- **Tree Health Monitoring**
- **Field Survey for Verification**

Tree Counting

with Deep Learning in ArcGIS Pro

- **Tree Health Monitoring**
- **Field Survey for Verification**



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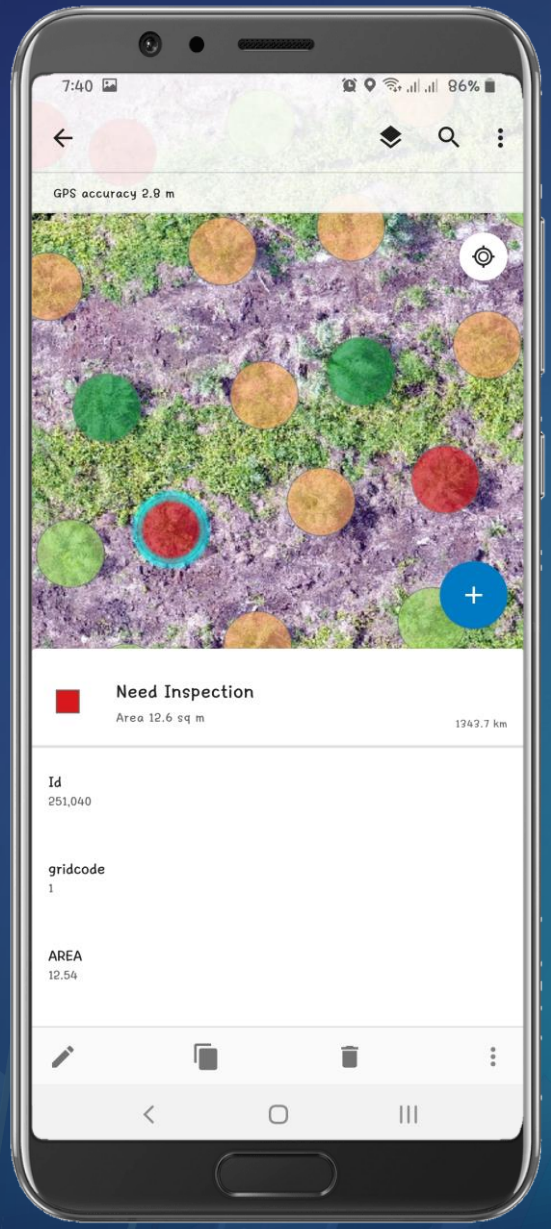

Building Extraction

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End to End Building Extraction Workflow

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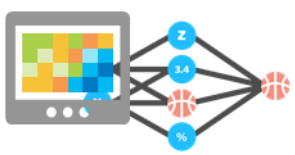
Imagery Prep

Data Labelling



Train & Consume Models

Deploy Models to Production

Run Inference at SCALE

Feedback Loop

Take Action

Demo

Conclusion

- Deep Learning workflow helps simplify & accelerate object detection process
- Deep Learning is supported in ArcGIS Pro + Image Analyst Extension
- ArcGIS Pro support end-to-end workflow
- GeoAI capabilities could be integrated with other open science libraries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