Modernizing National Government with GeoAI & ArcGIS

National Government Webinar Series

Today's Presenters

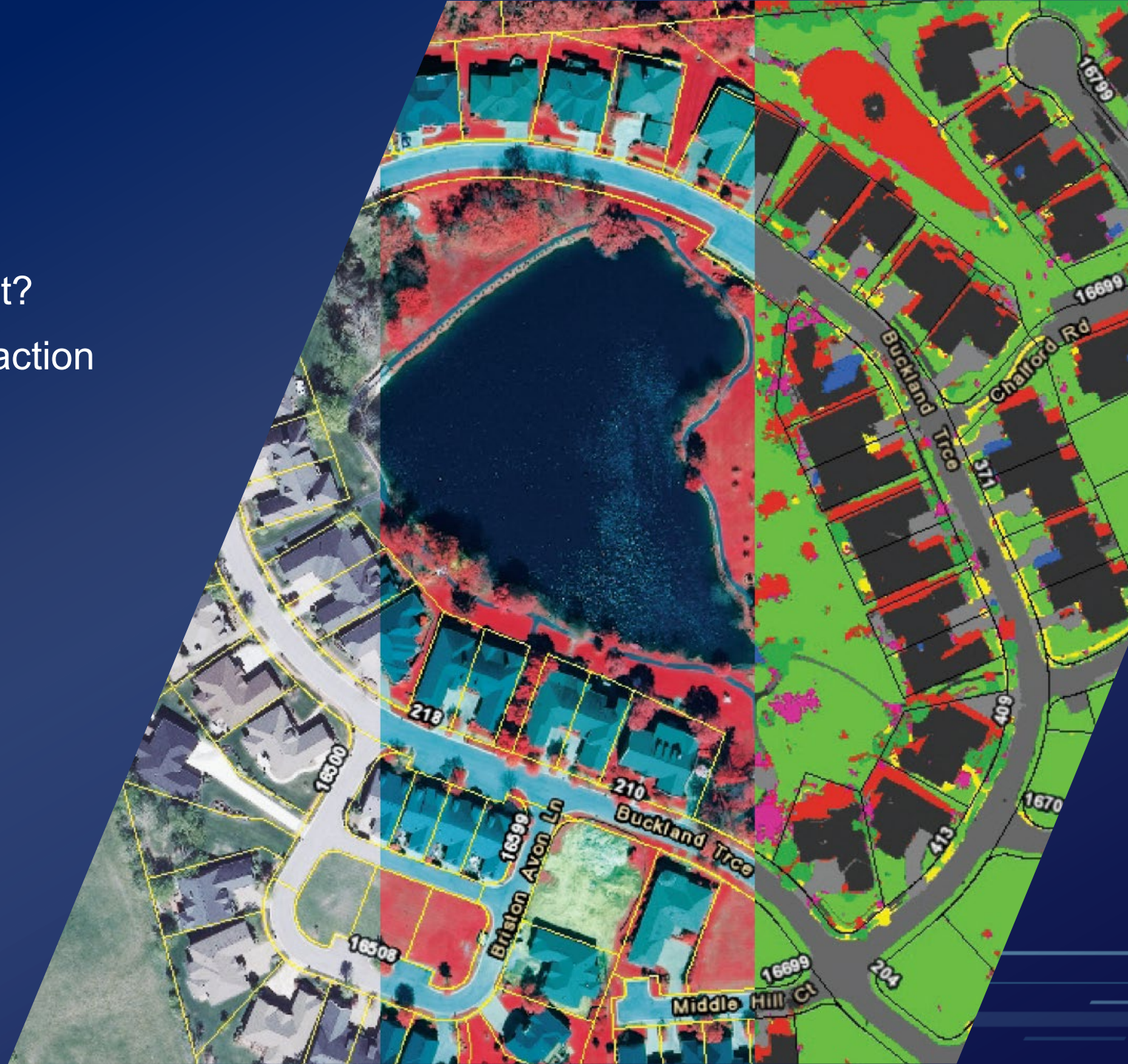
Mark Cygan
Director of National Mapping Solutions

Linda Peters
Global Business Development Manager Statistics

Katherine Smyth
Solution Engineer Team Lead | National Government

Agenda

- Why GeoAI for National Government?
- Change Detection and Feature Extraction
- Demonstration
- GeoAI and Notebooks
- Demonstration
- Resources
- Open Q&A

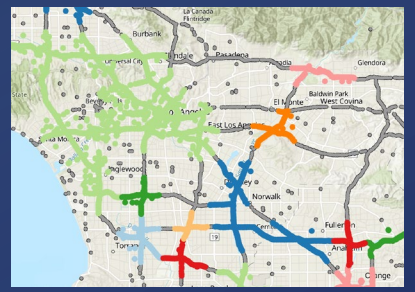


GeoAI can help with

Prediction

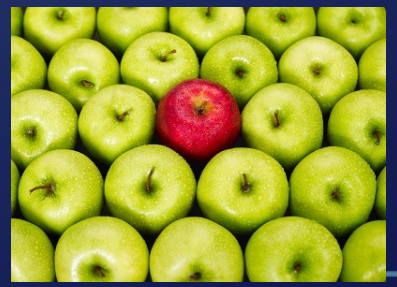
Object & Feature Detection

Clustering



Land Classification

Anomaly Detection



Challenges for National Government Organizations

- Expanding Stakeholder Expectations
- Escalating Demand for Broader Range of Information Products
- Delivering Near Real Time Information
- Increasing Demand for Better Resolution and Higher Quality Data
- Overall challenge of accuracy – v privacy

- Smaller Budgets and Revenues
- Less Staff and Resources
- Shrinking Timelines from Data Collection to Delivery
- Reduced Perception of Relevance
- Realities of Covid-19 and impacts on business continuity

GeoAI Benefits to National Government Organizations

Enabling Us to Do More with Less

- Responsiveness - Speeding Timely Information to Decision Makers
- Increasing Relevance - Expanding use of Technology, Data Analysis & Information Delivery
- Saving Time, Money, Labor and Environmental Impact
- Increasing Efficiency and Expanding Capacity
- Improving Accuracy and Engagement with User Community

GeoAI – Priorities with High Value to National Government

- **High-Value Workflows**
  - **Change Detection of Areas & Features**
  - **Feature Identification & Extraction**
  - **Analysis and Assessment**

High Value Use Cases

Change Detection for Roads, Buildings and Land Cover

Road Extraction for National Mapping and Census Enumeration

Buildings for National Census Pre-Enumeration and National Mapping

National Land Cover & Agricultural Census

Imagery and Remote Sensing

ArcGIS is a comprehensive imagery platform

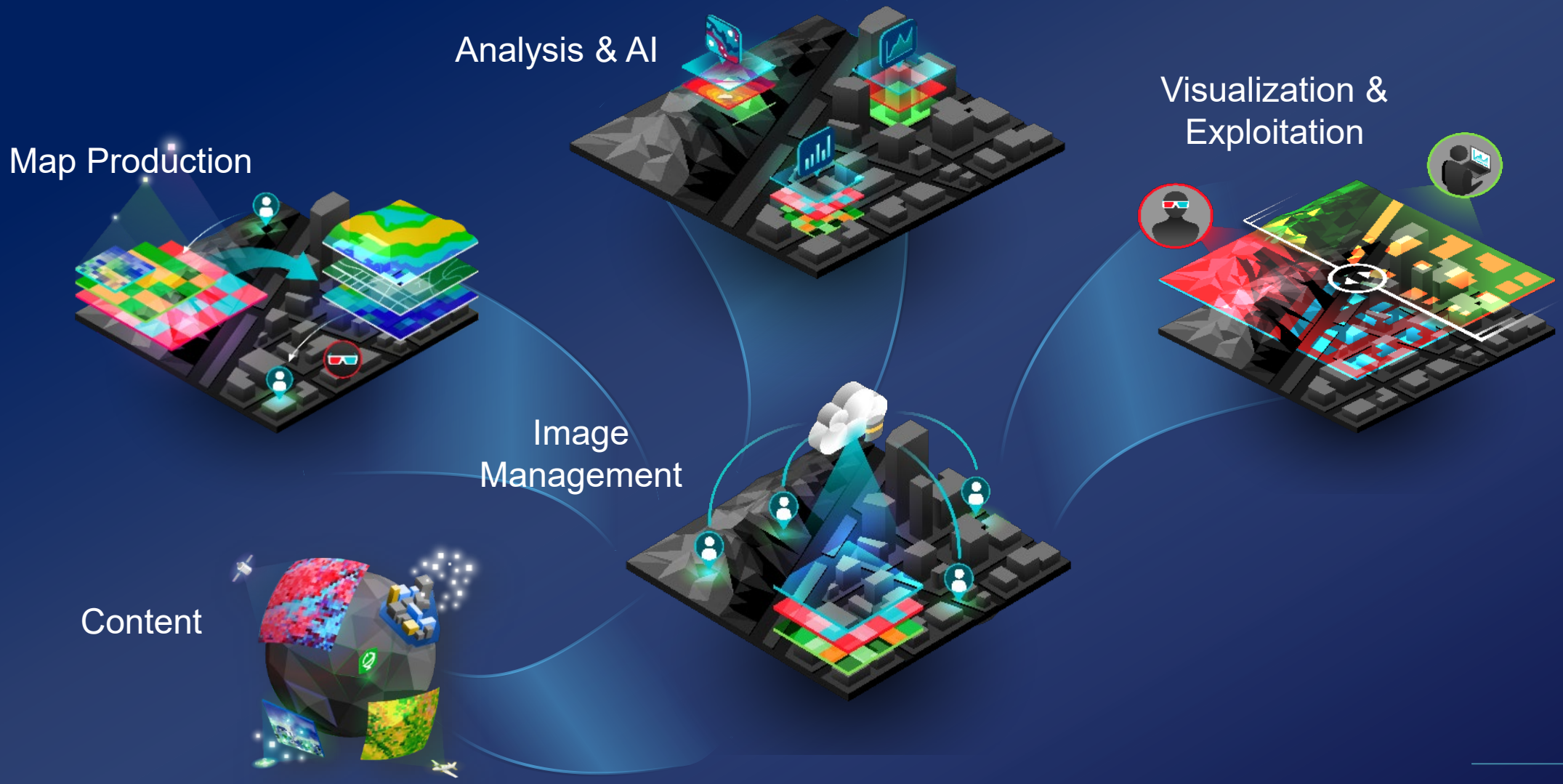
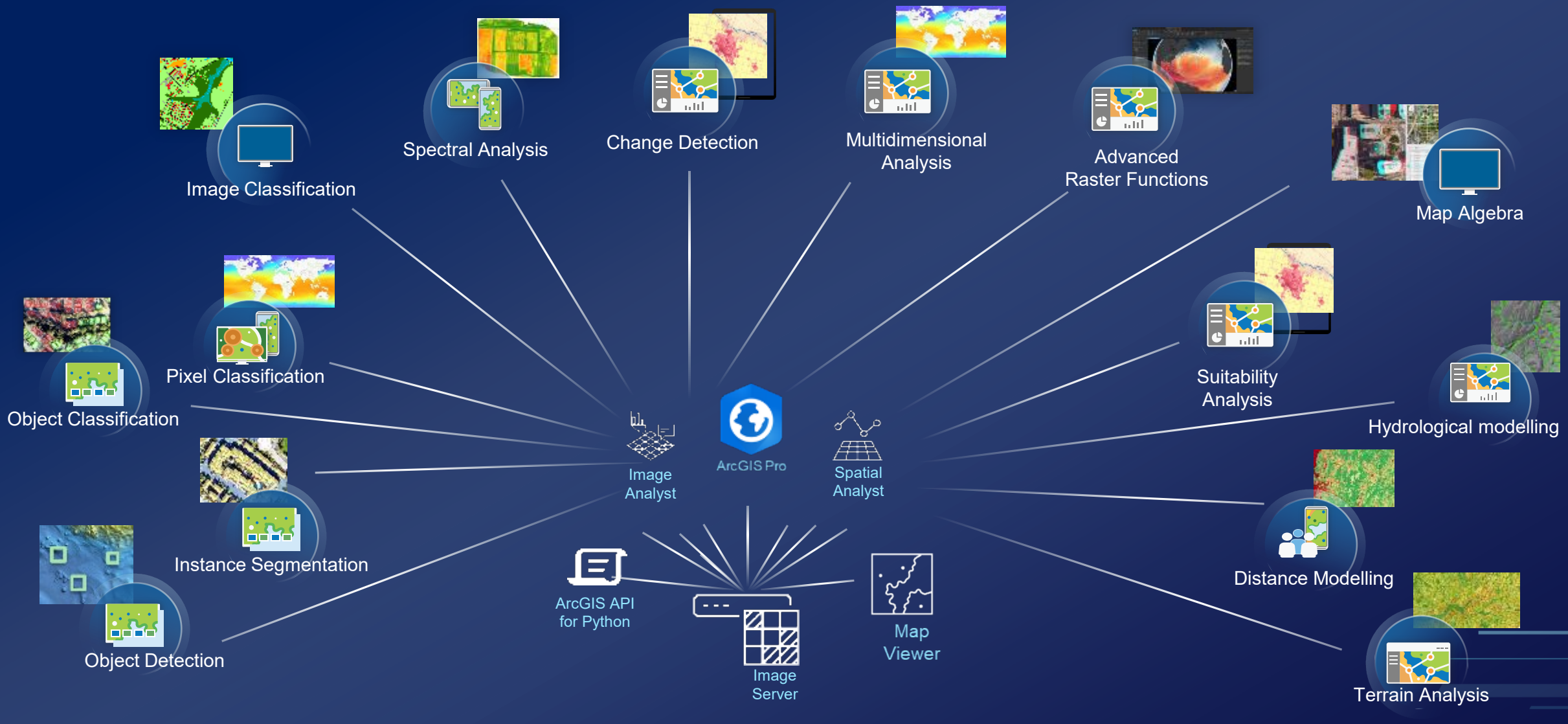


Image Analysis Extracting Information From Imagery



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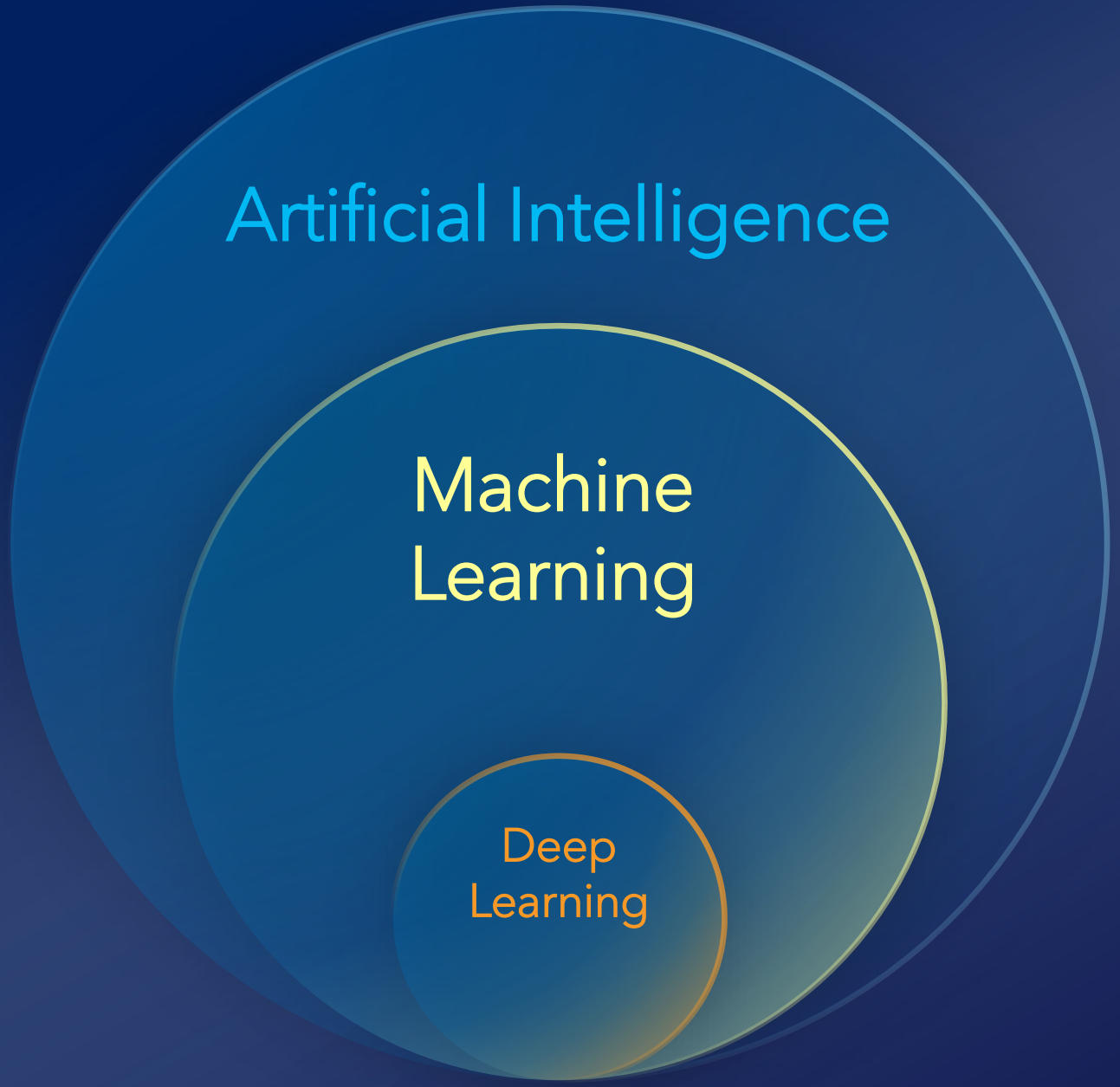
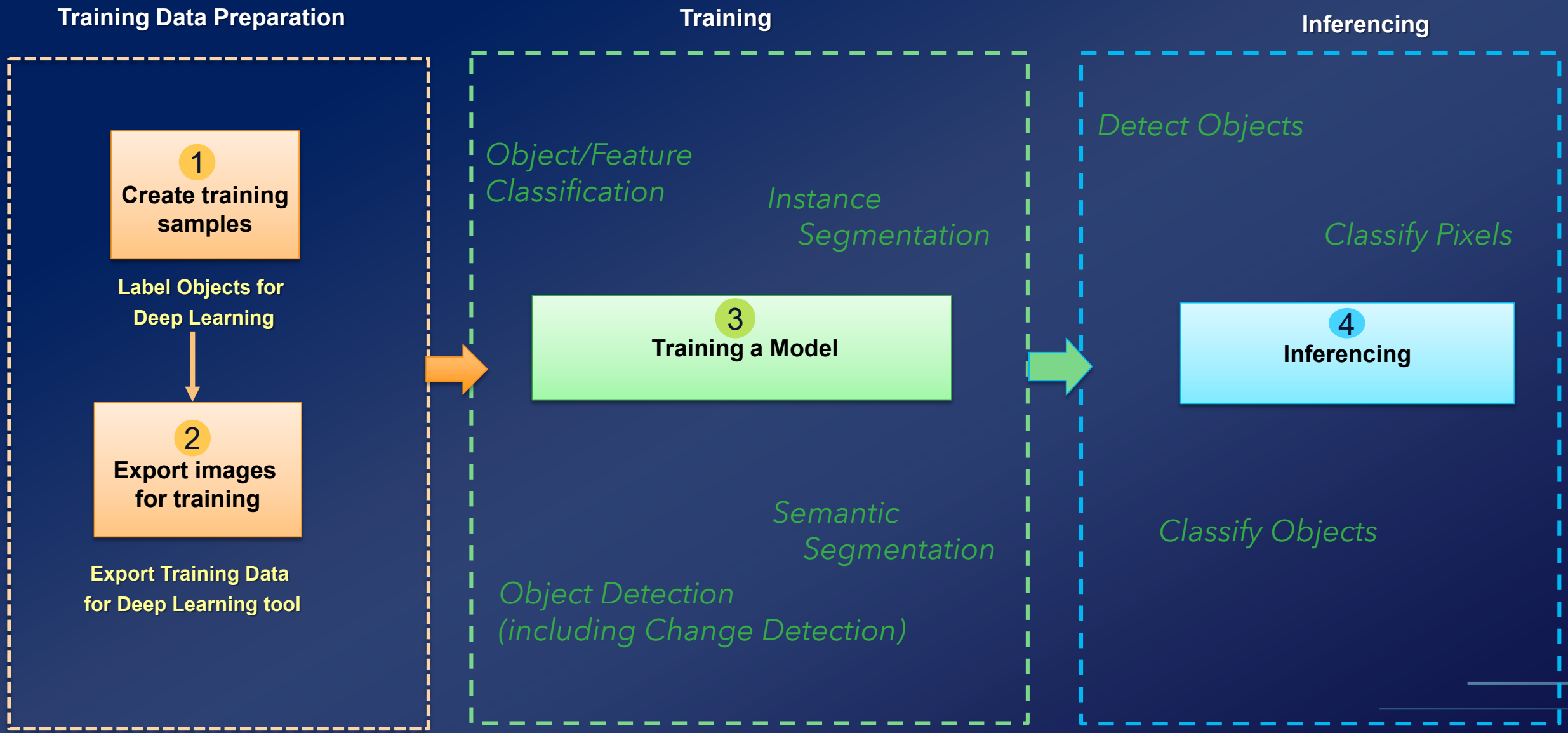

Artificial Intelligence
Machine Learning
Deep Learning

Deep Learning in ArcGIS

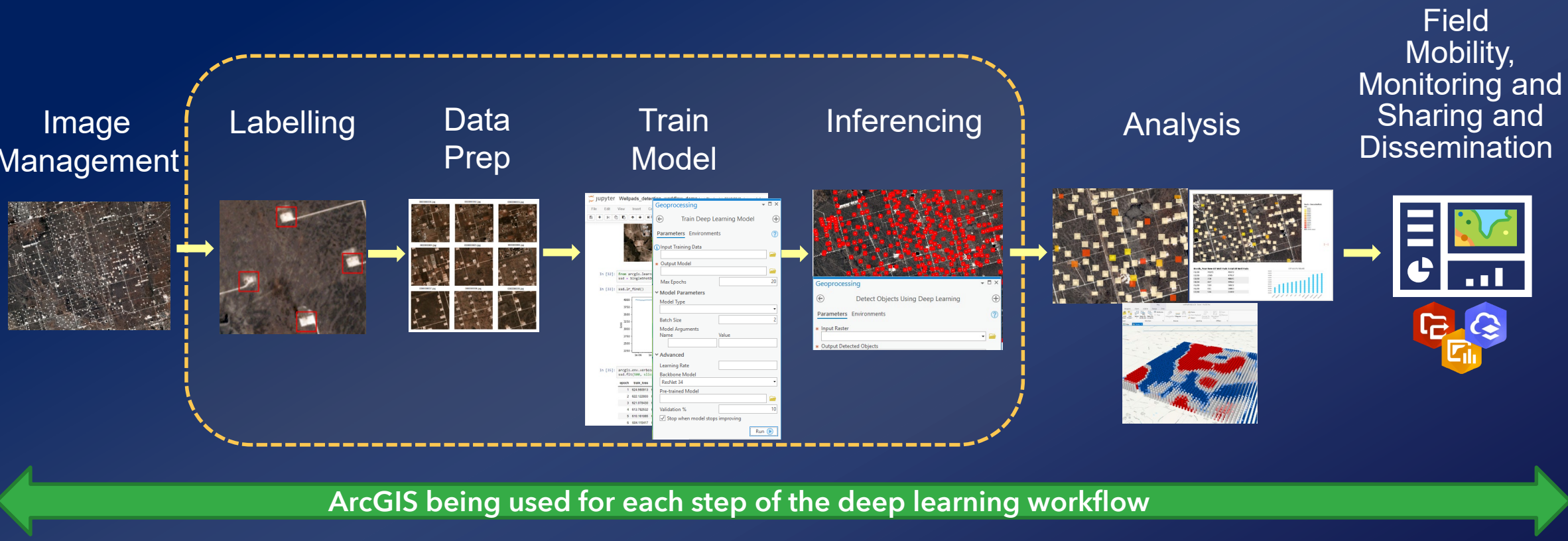
Integration

ArcGIS Deep Learning Workflow

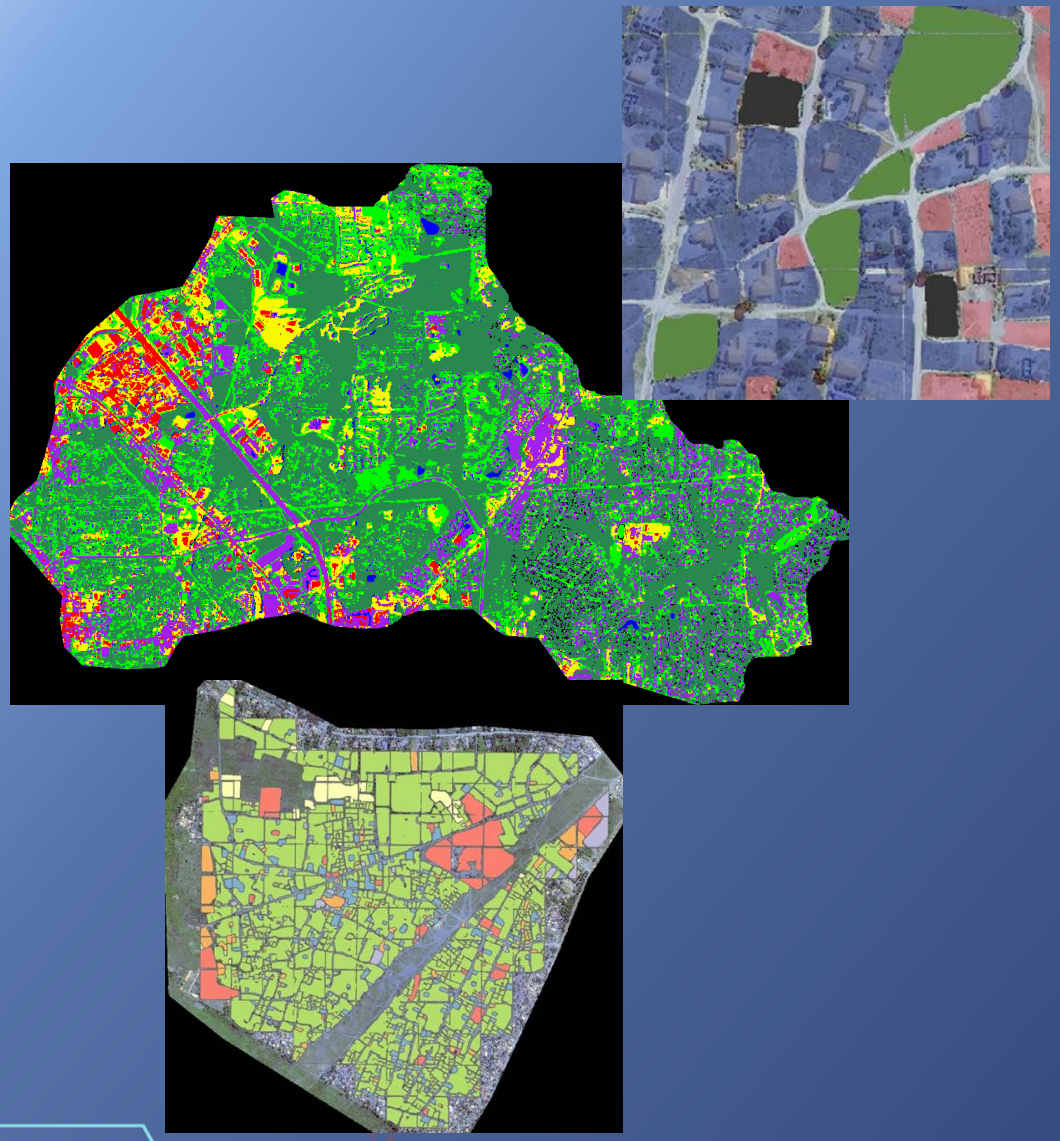


Deep Learning Workflow in ArcGIS

End-to-end from raw imagery to structured information products



ArcGIS being used for each step of the deep learning workflow



Demo

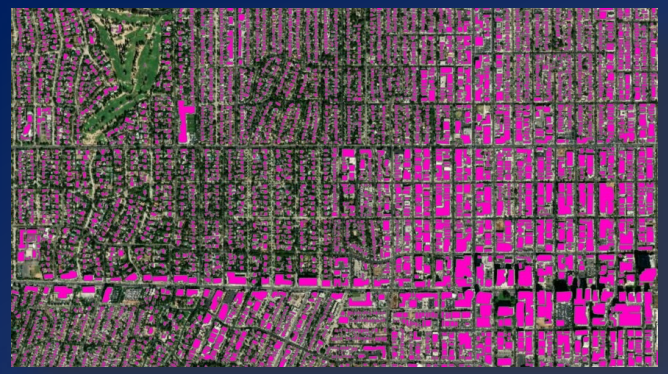
Land Cover Change Detection and
Map Feature Extraction
using Deep Learning

Examples for Imagery AI Workflows

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

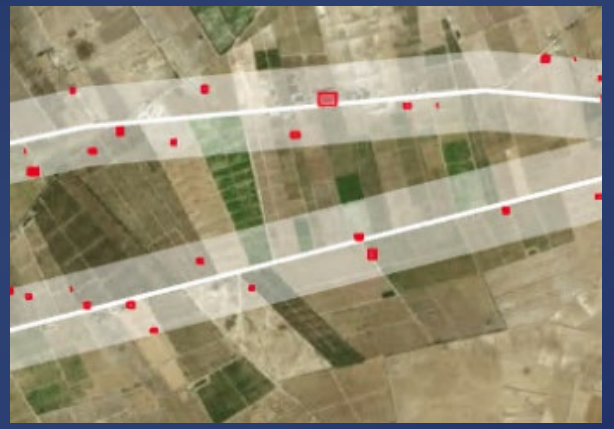
Damaged Structures

Building Footprints



Land Cover

Pipeline Encroachment

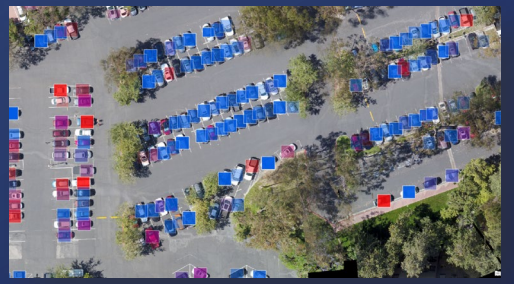


Roads

Oil Pads

Road Cracks

Cars



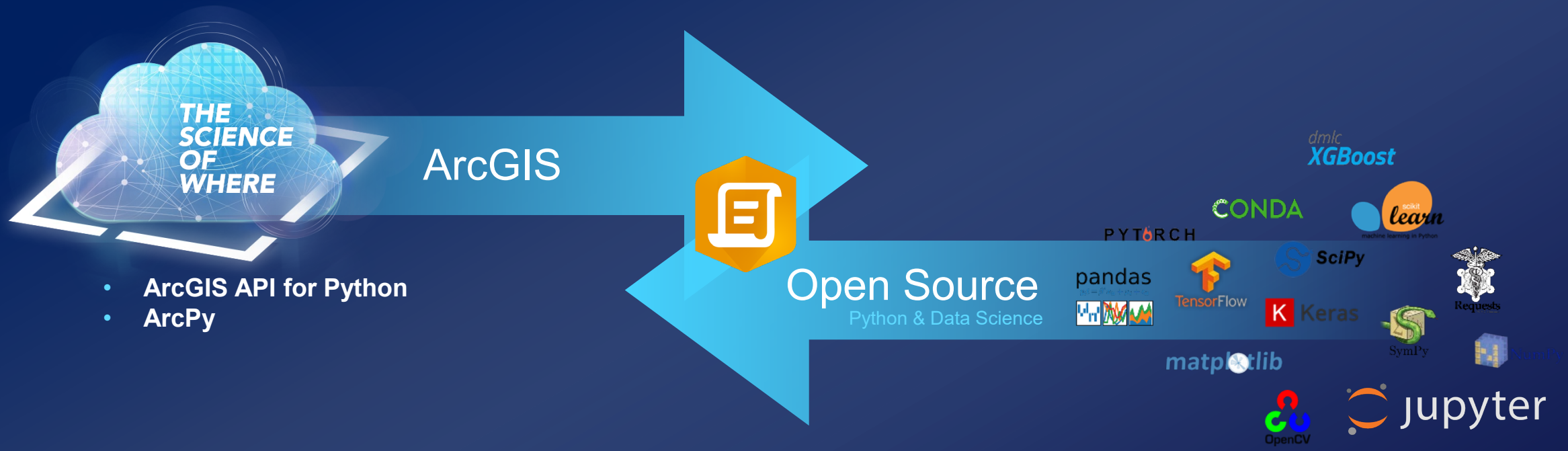
Palm Trees

Swimming Pools

Poll Question

Please Tick the Boxes that Apply to Your Organization

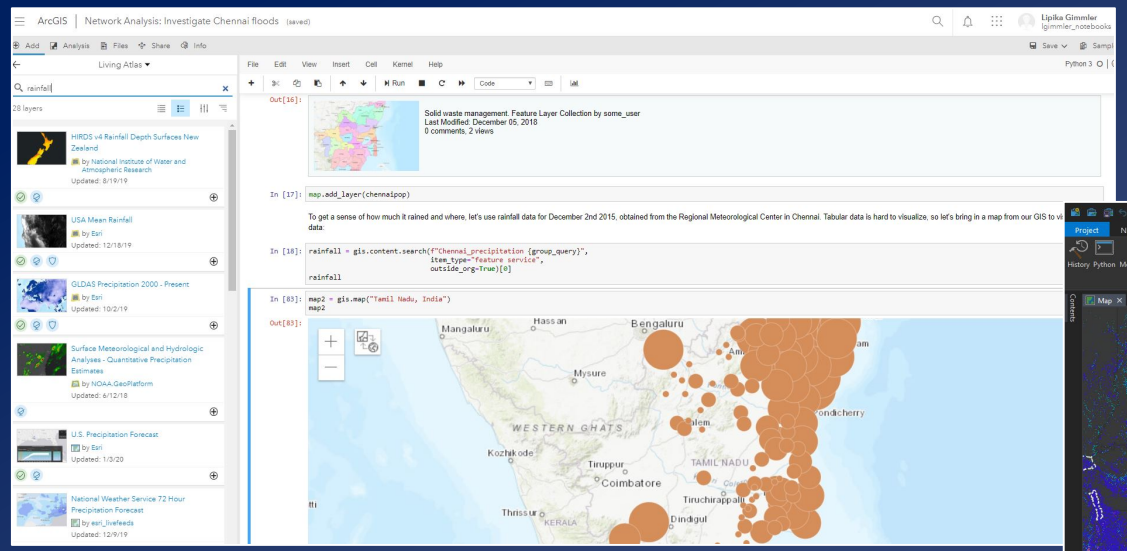
ArcGIS Notebooks sits at the intersection of ArcGIS and open data science



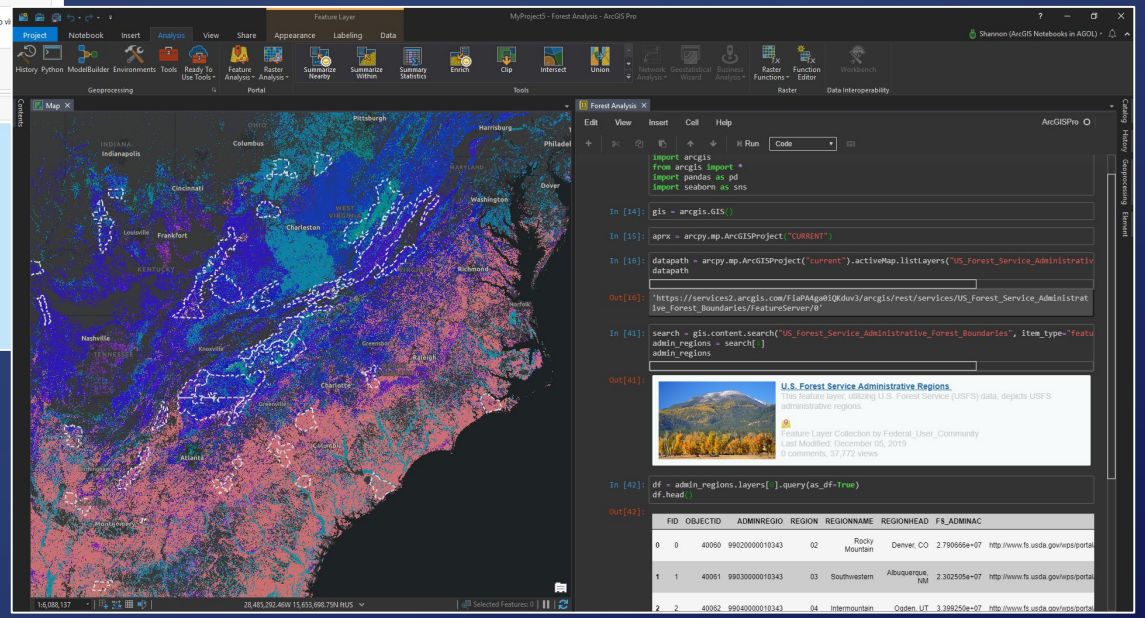
- ArcGIS API for Python
- ArcPy

ArcGIS Notebooks

A Spatially Optimized Jupyter experience within ArcGIS



Integrated Python notebooks in ArcGIS Pro allow you to seamlessly move data and analysis results between both.



Hosted notebooks allow for easy searchability of datasets and to bring in analysis tools as code snippets.

Jupyter Notebook Integration for Modeling and Automation

ArcGIS Notebooks

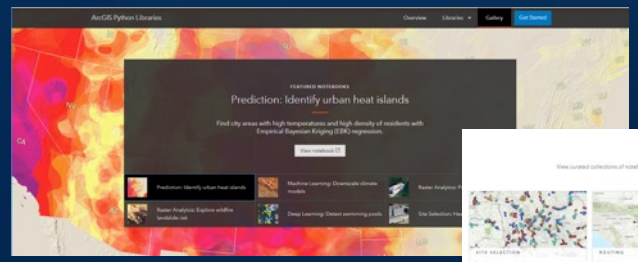
NEW
Pro
Integrated
Easy - No Setup

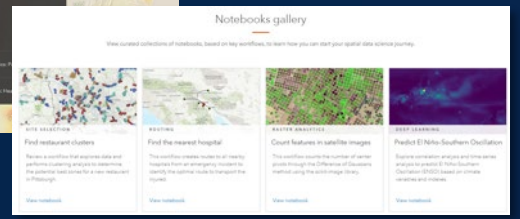
Enterprise
Specialized Server
Extensible

NEW
Online
Available as
an Extension

ArcGIS Pro

ArcGIS Online





Notebook Gallery

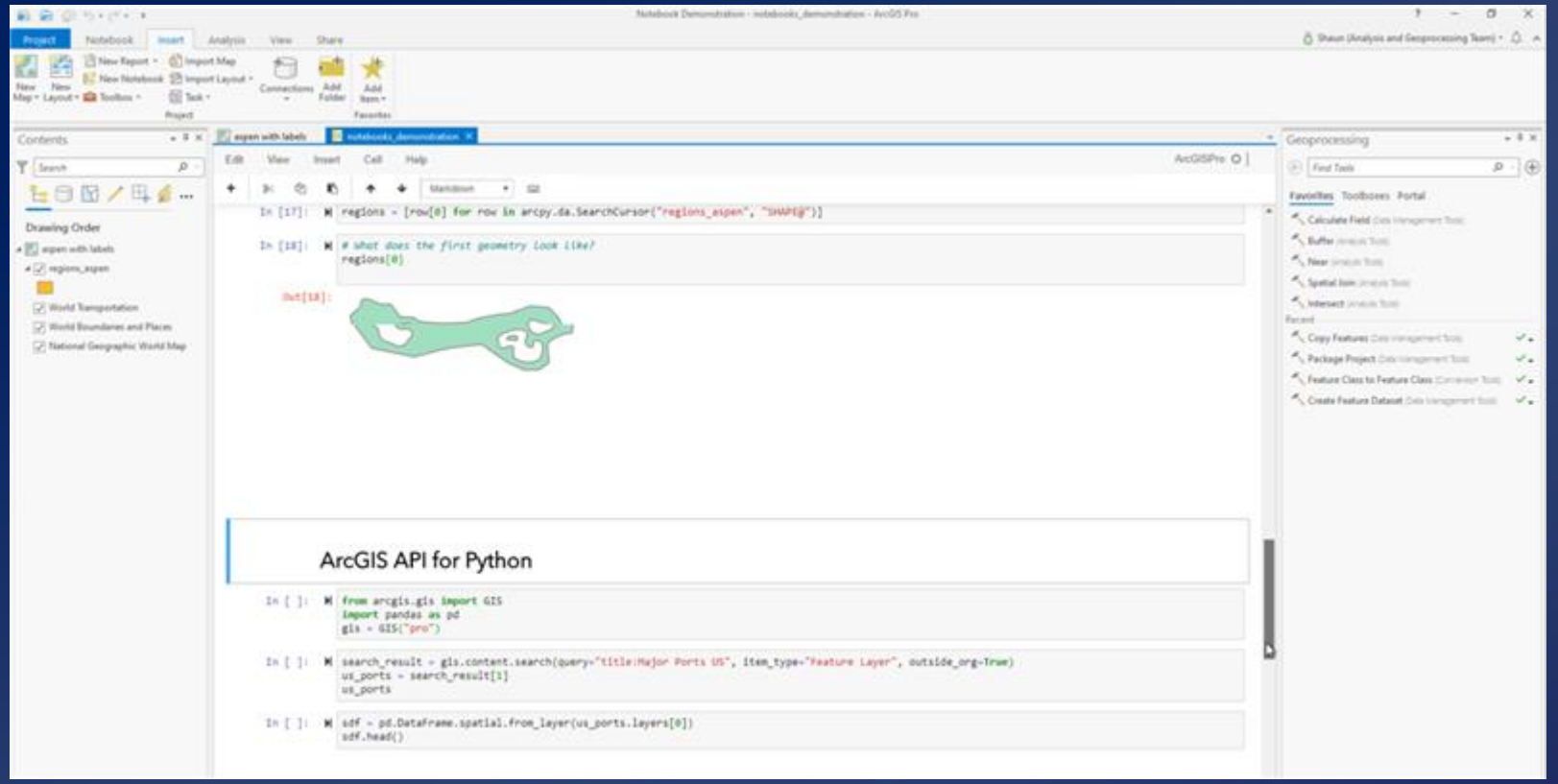
Includes ArcGIS Python Libraries and
100s of Open Science Libraries

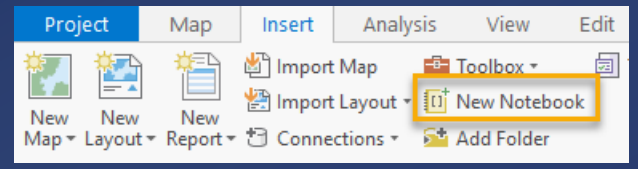
New & Improved

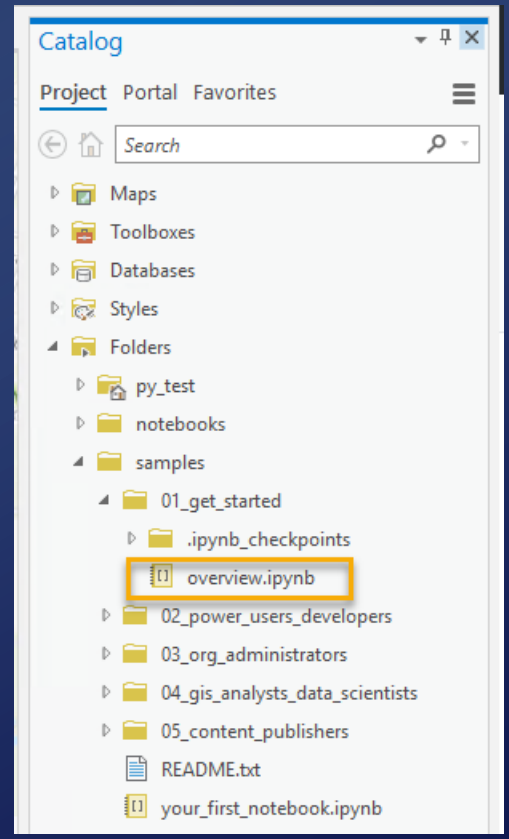
- Pro & Online
- Scheduling
- Parameterization
- Deep Learning Models
- Notebook Gallery

Scripting Processes and Workflows

ArcGIS Pro 2.5 seamlessly integrates Python Notebooks







ArcGIS Python Libraries

Python for Spatial Data Science

Convert and manage geographic data

Build machine and deep learning models

Perform advanced analytics

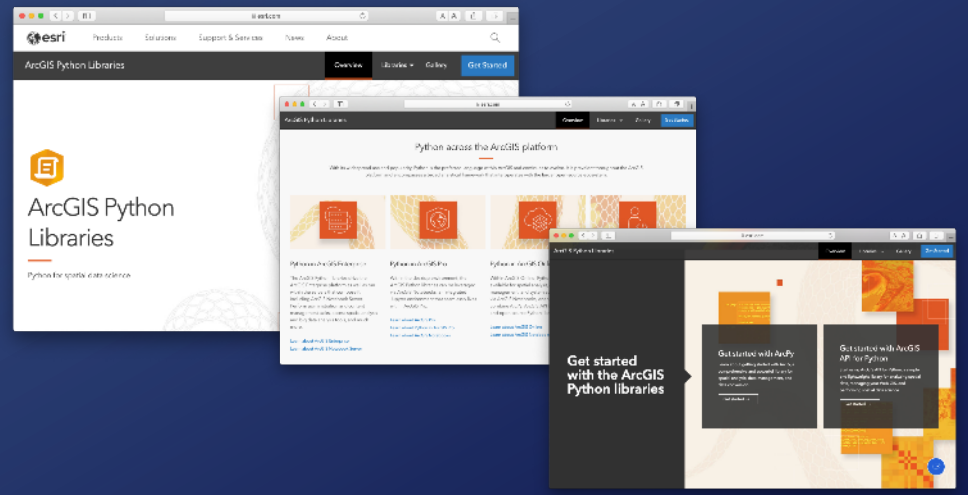
Automate workflows

ArcGIS API for Python

Simple and lightweight library for analyzing spatial data, managing your Web GIS, and performing spatial data science.

ArcPy

Comprehensive and powerful library for spatial analysis, data management, and conversion.



Available across ArcGIS. . .

. . . In Pro, Enterprise, and Online

Deep Learning in ArcGIS API for Python (released version 1.8.1)

Make Deep Learning image analysis easier using arcgis.learn module

1. Export and Prepare Training Data

arcgis.learn.export_training_data
arcgis.learn.prepare_data

2. Train Deep Learning Models

- ***Object Detection:***
  - arcgis.learn.SingleShotDetector
  - arcgis.learn.RetinaNet
  - arcgis.learn.MaskRCNN
  - arcgis.learn.FasterRCNN
  - arcgis.learn.YOLOv3
- ***Pixel Classification:***
  - arcgis.learn.UnetClassifier
  - arcgis.learn.PSPNetClassifier
  - arcgis.learn.DeepLab
- ***Object Classification:***
  - arcgis.learn.FeatureClassifier
- **Others** (Text, Point Cloud, Tabular)

3. Run Inference at SCALE

arcgis.learn.detect_objects
arcgis.learn.classify_objects
arcgis.learn.classify_pixels

4. Model Management

arcgis.learn.list_models
arcgis.learn.Model
- Model.query_info
- Model.install
- Model.uninstall

More to come …

ArcGIS API for Python

arcgis.learn module

The `arcgis.learn` module in **ArcGIS API for Python** enables Python developers and data scientists to **easily train and use deep learning models with a simple, intuitive API.**

Train Models

Before

8. Conver Label to One Hot Vector

9. Define IoU Metric

10. Define Custom Loss Function

11. Set Parameters before Training

Land Cover Classes

- Dozens of lines of Code
- Installing External DL Frameworks
- HARD!

After

- 3-5 lines
- Simple or no Installation (ArcGIS Pro & Notebooks)
- EASY

Train SingleShotDetector Model

```
from arcgis.learn import SingleShotDetector

ssd = SingleShotDetector(data, grids=[9], zooms=[1.0], ratios=[[1.0, 1.0]])
```

```
ssd.fit(10, lr=slice(1e-3, 1e-2))
```

ArcGIS API for Python

Not just “training”!

Data Preparation

- arcgis.learn.export_training_data
- arcgis.learn.prepare_data

Training DL Models

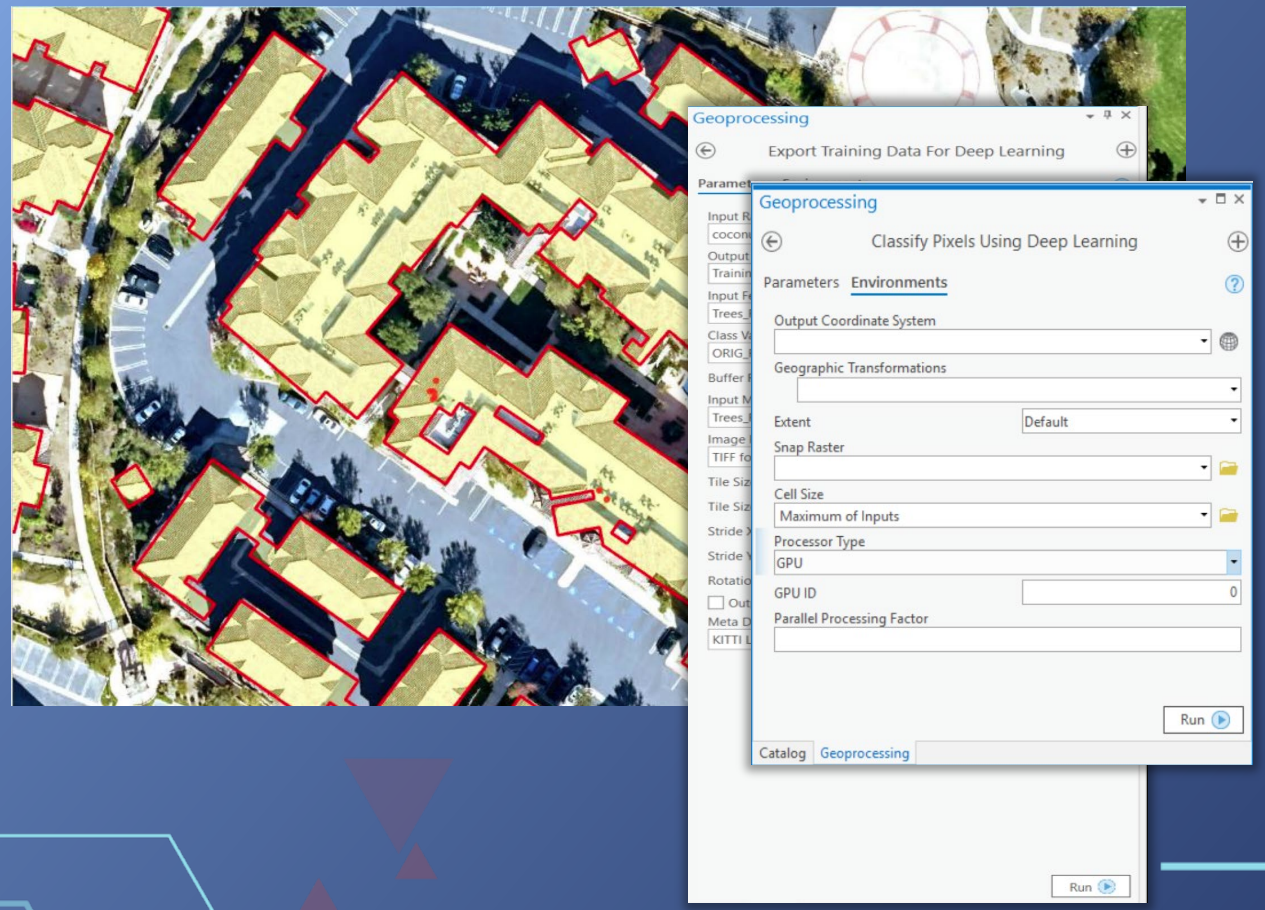
- arcgis.learn.FeatureClassifier
- arcgis.learn.SingleShotDetector
- arcgis.learn.RetinaNet
- arcgis.learn.MaskRCNN
- arcgis.learn.UnetClassifier
- arcgis.learn.PSPNetClassifier
- arcgis.learn.DeepLab
- arcgis.learn.PointCNN
- arcgis.learn.EntityExtractor

Model Management

- arcgis.learn.list_models
- arcgis.learn.Model
  - Model.install
  - Model.uninstall
  - Model.query_info

Inference APIs

- arcgis.learn.detect_objects
- arcgis.learn.classify_pixels
- arcgis.learn.classify_objects

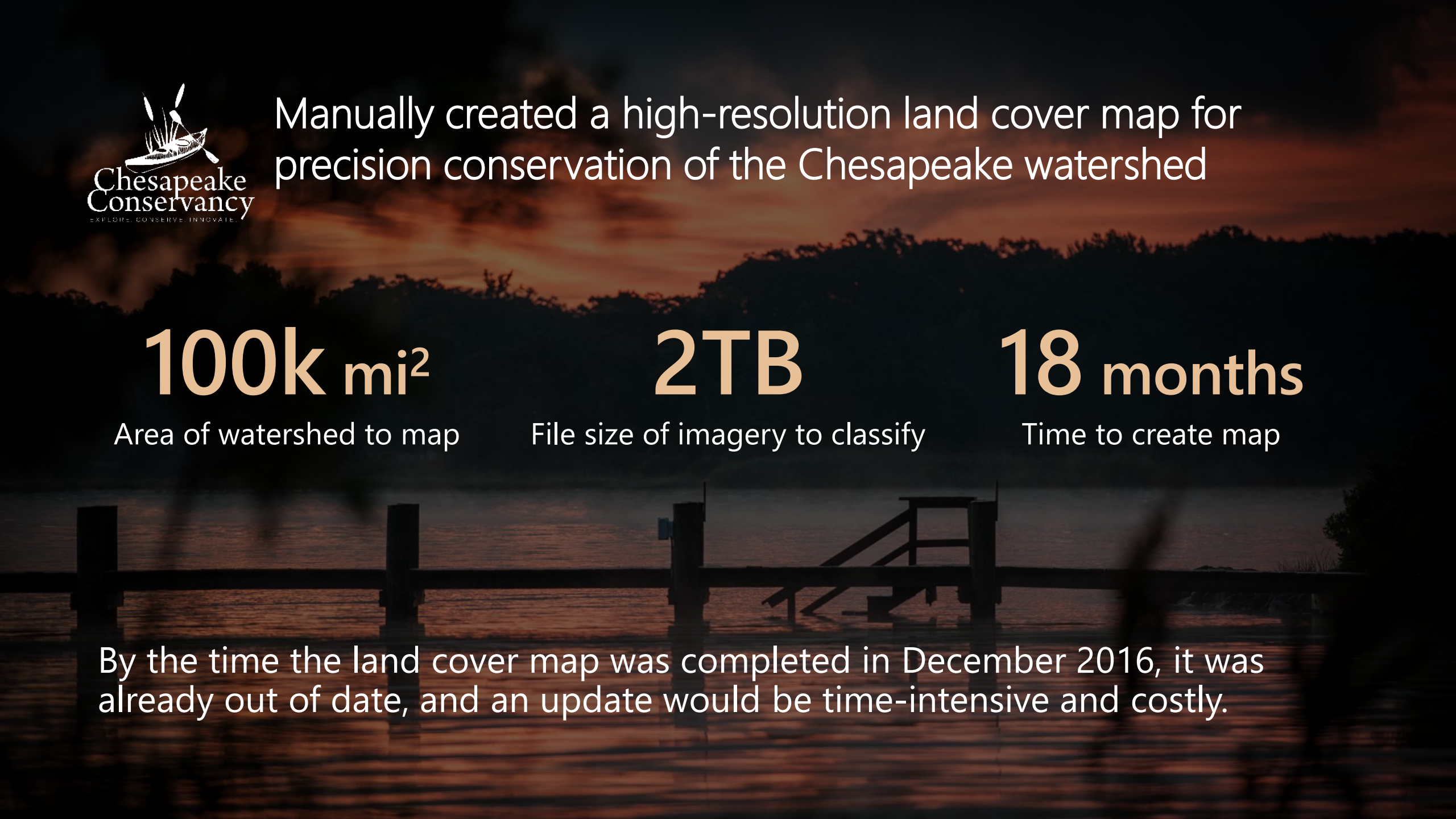


Demo

Notebooks and Deep Learning

Use-cases

Examples of GeoAI projects from the community


Chesapeake Conservancy
EXPLORE. CONSERVE. INNOVATE.
Manually created a high-resolution land cover map for precision conservation of the Chesapeake watershed
100k mi²
Area of watershed to map
2TB
File size of imagery to classify
18 months
Time to create map
By the time the land cover map was completed in December 2016, it was already out of date, and an update would be time-intensive and costly.

Land Classification Model

Working Platform: GeoAI Virtual Machine

Dataset: *100k mi² of imagery at 1-meter resolution, split in half geographically into train and test sets*

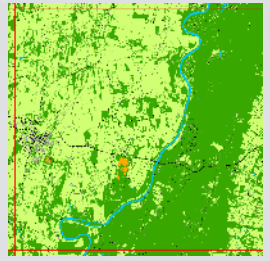
Labeled Training Images
Chesapeake Conservancy Dataset

Convolutional Network Architecture
23 layer U-Net

Test Images

Land Classification Model

Land Cover Map



Algorithm Results

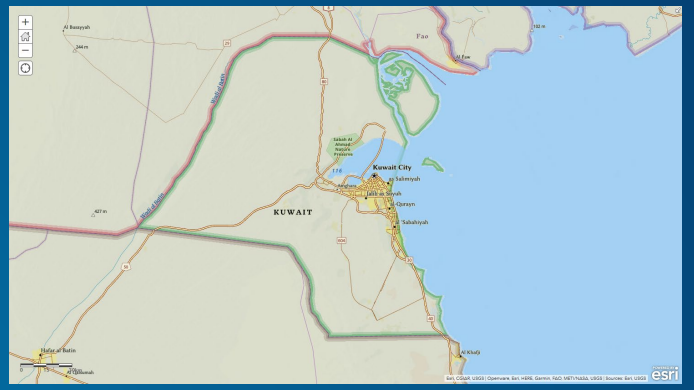
91%
Average land classification accuracy

150
Hours taken, previously taken 2500

16x
Faster than Chesapeake Conservancy's previous methods

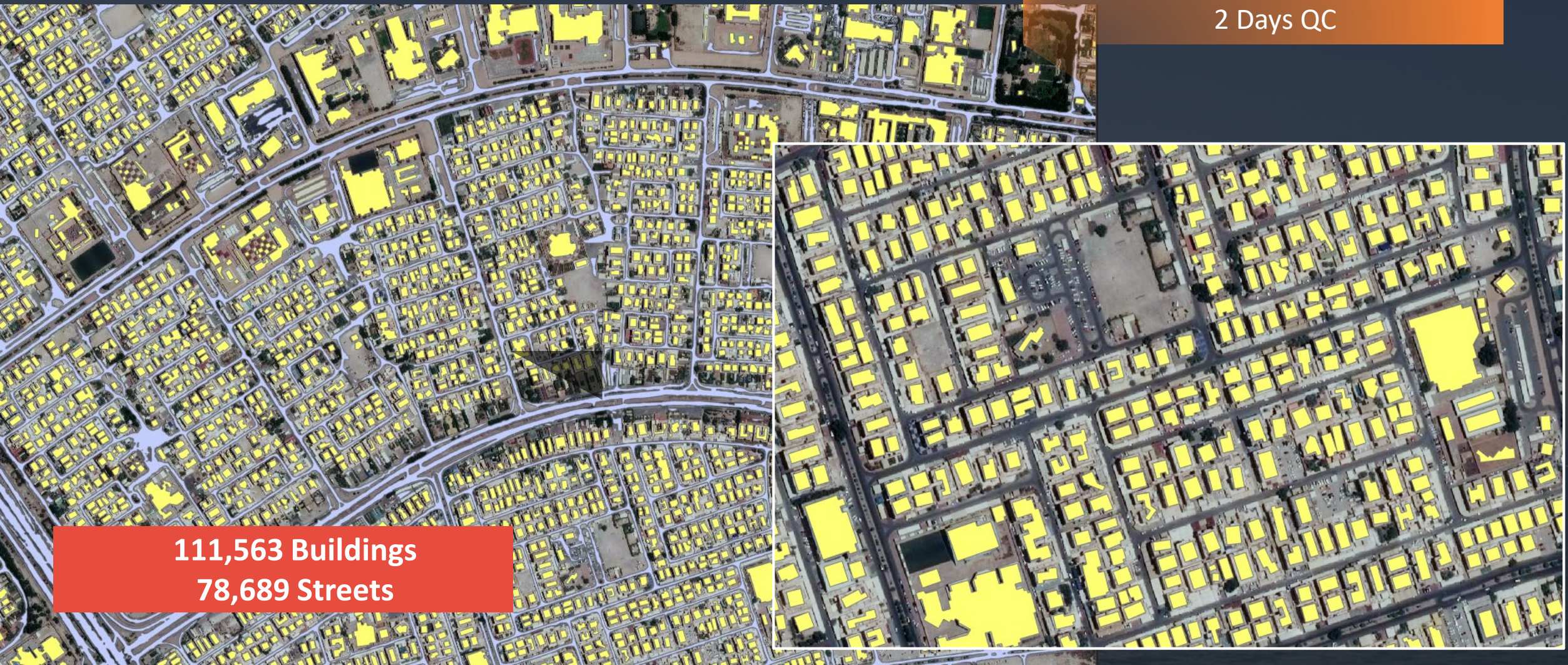
Kuwait

الهيئة العامة للمعلومات المدنية
The Public Authority For Civil Information



Output

1.5 hours processing
2 Days QC



111,563 Buildings
78,689 Streets

PACI Kuwait and GeoAI

- More Responsive
- Improved Accuracy
- Savings in Time and Money
- Expanded Internal Capacity
- Maximized Return on Investment

Poll Question

Please Tick the Boxes that Apply to Your Organization

AI is not one product. It spans the ArcGIS platform.

Where we offer machine learning integration.

ArcGIS API for Python

ArcGIS Velocity

ArcGIS Notebooks

ArcGIS Pro

ArcGIS Online

ArcGIS Enterprise

ArcGIS Hub - Citizen Data Science

ArcGIS QuickCapture - Edge AI (in R&D)

ArcGIS Insights

ArcGIS Pro for Intelligence

Resources

- **ArcGIS.Learn Documentation:** https://developers.arcgis.com/python/api-reference/arcgis.learn.html
- **Sample Notebooks** https://developers.arcgis.com/python/sample-notebooks/
- **ArcGIS API for Python** Building Footprint Extraction using DL
- **GeoAI blogs** https://medium.com/geoai
- **UC2020** Geospatial Deep Learning with ArcGIS
- **YouTube Videos: Search for "ArcGIS Deep Learning"**
- **7 Part Blog Series on GeoAI**
  - Future Impacts on Mapping and Modernization by GeoAI http://alturl.com/chy5x

Question & Answer

Please Enter Questions in the Questions Window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THE
SCIENCE
OF
WHERE