GeoAI and GenAI in ArcGIS

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Agenda

- Introduction to GeoAI
- Where Can You Find AI in ArcGIS?
- How Can We Use GeoAI in ArcGIS (Real-world examples)?
- Machine Learning Lifecycle
- Models in GeoAI
- Machine Learning Tools in ArcGIS
- Demos
- AI Assistants in ArcGIS

Introduction to GeoAI



AI is used today literally everywhere…

Autonomous Cars



Sentiment Analysis



Chatbots



Robots



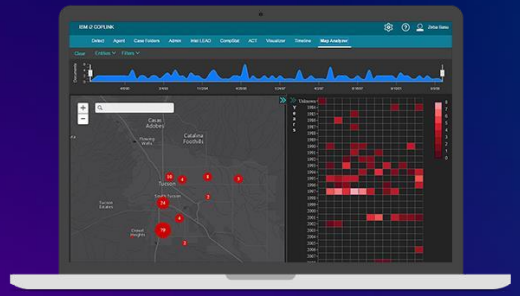
Advanced Video Analytics



Predictive Maintenance



Crime Prediction



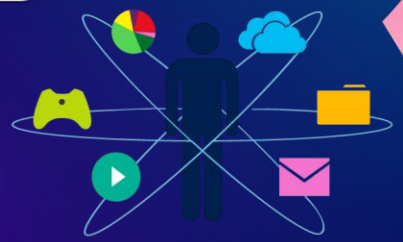
Cancer Detection



Facial Recognition



Personalized Marketing



Advanced Satellite Intelligence



Stock Market Prediction



AI > ML > DL

Artificial Intelligence

Reasoning



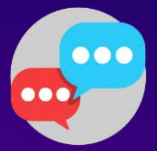
Knowledge Representation



Perception



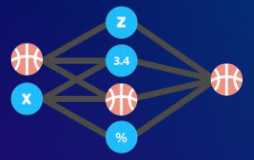
NLP



Robotics



Machine Learning



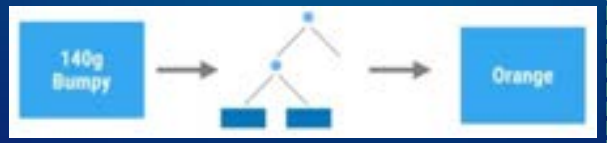
Machine Learning

Supervised Learning

1. Training *features* *Labels*

	Weight	Texture	Label
Examples	150g	Bumpy	Orange
	170g	Bumpy	Orange
	140g	Smooth	Apple
	130g	Smooth	Apple
	...	...	...

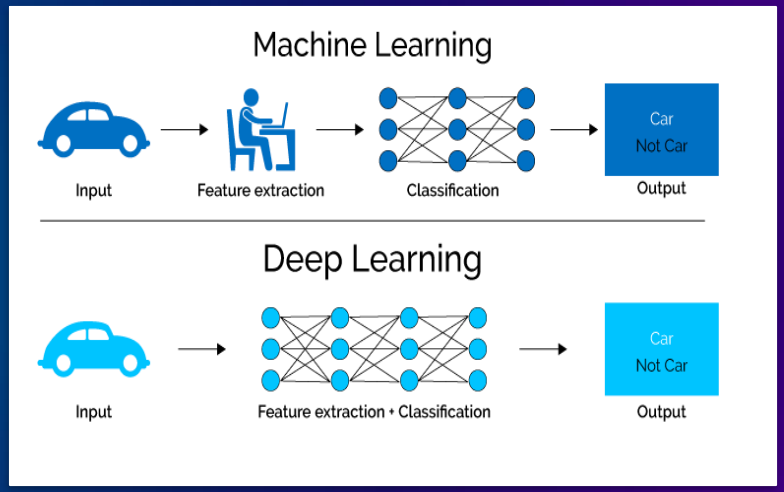
2. Predicting



Unsupervised Learning
Reinforcement Learning

Deep Learning

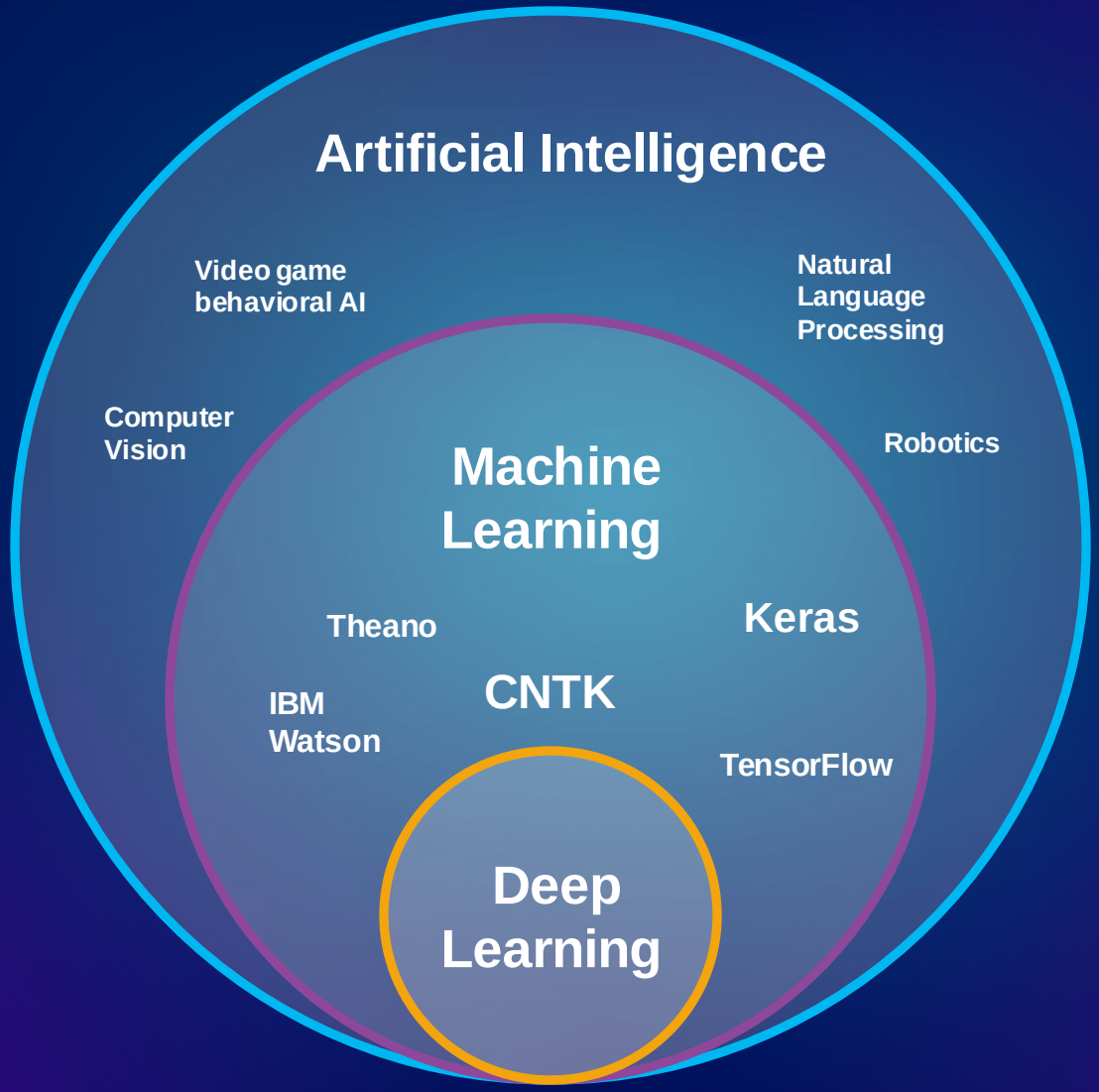
Deep Supervised Learning





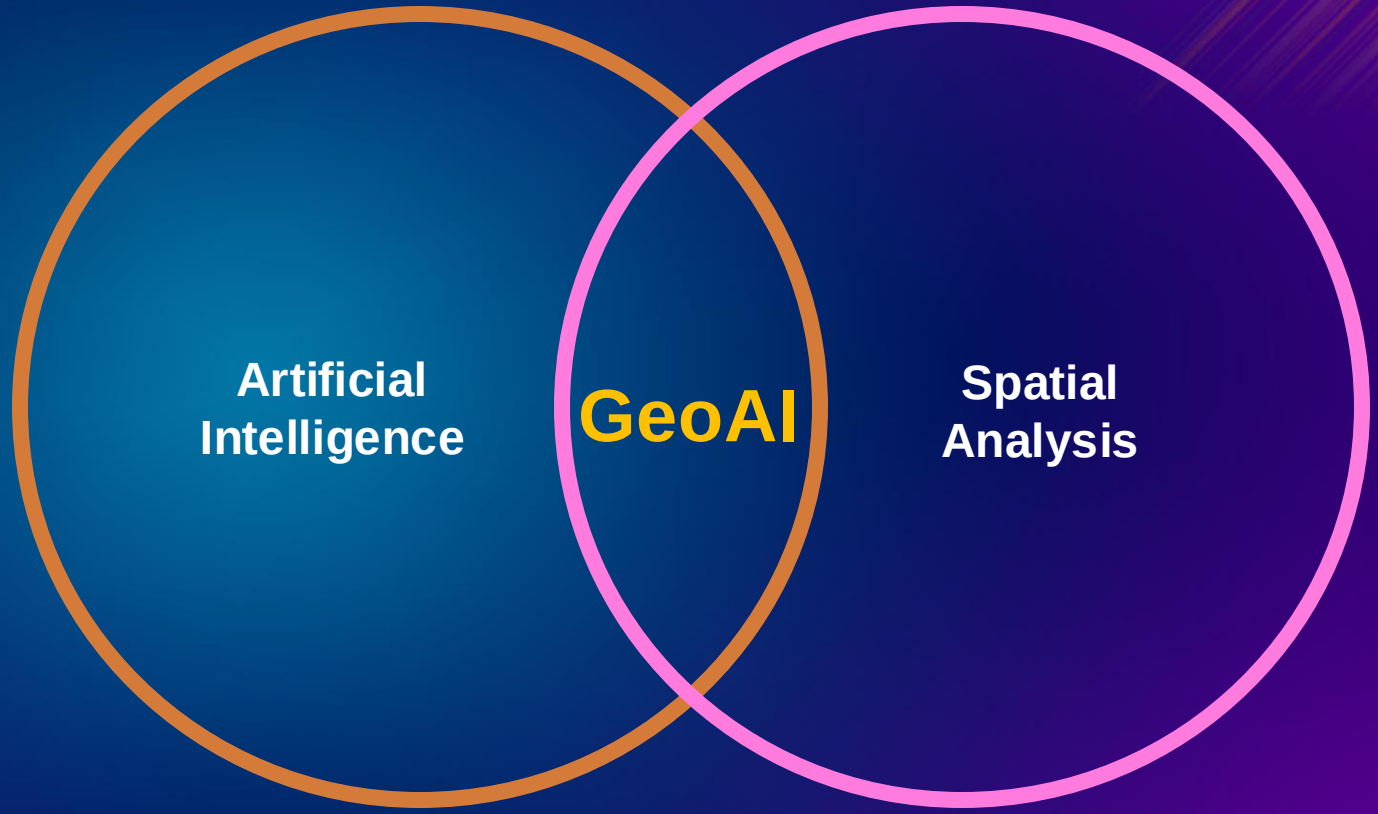
Dog

The Hierarchy of Intelligence: AI, ML, and DL



Where AI Meets GIS

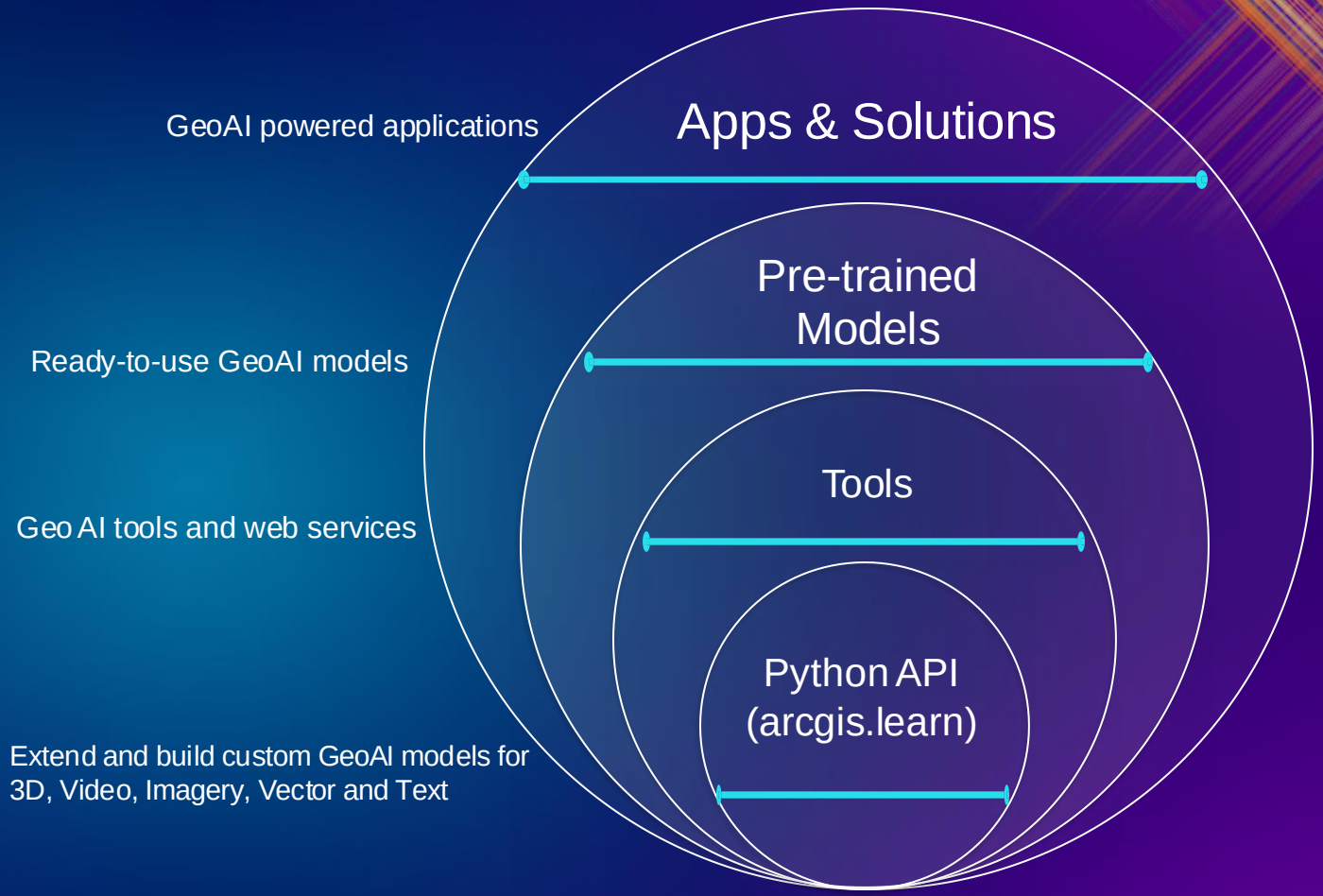
GeoAI combines **Artificial Intelligence** and Geospatial Technology to extract insights from spatial data, enabling smarter decision-making.



The GeoAI Ecosystem: From APIs to Applications

APIs, tools, pre-trained models, and applications interact to create powerful geospatial solutions.

At the core is the flexibility of Python API, extending out to ready-to-use tools and applications that bring GeoAI to life.



What Can Machine Learning Do?



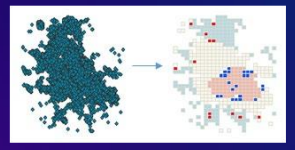
Extract features from imagery & lidar

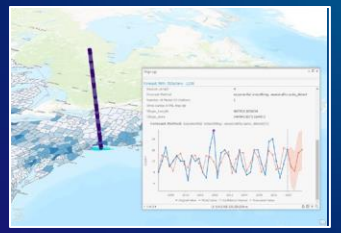


Make predictions



Find patterns & clusters





Detect anomalies





Extract insights from unstructured text

Where Can You Find AI in ArcGIS?

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



Where Can You Find AI in ArcGIS?

Where we offer machine learning integration.



ArcGIS API for Python

ArcGIS Analytics for IoT - in R&D

ArcGIS Notebooks ArcGIS Pro

ArcGIS Online ArcGIS Enterprise

ArcGIS Hub - Citizen Data Science

ArcGIS QuickCapture - Edge AI (in R&D)

ArcGIS Insights

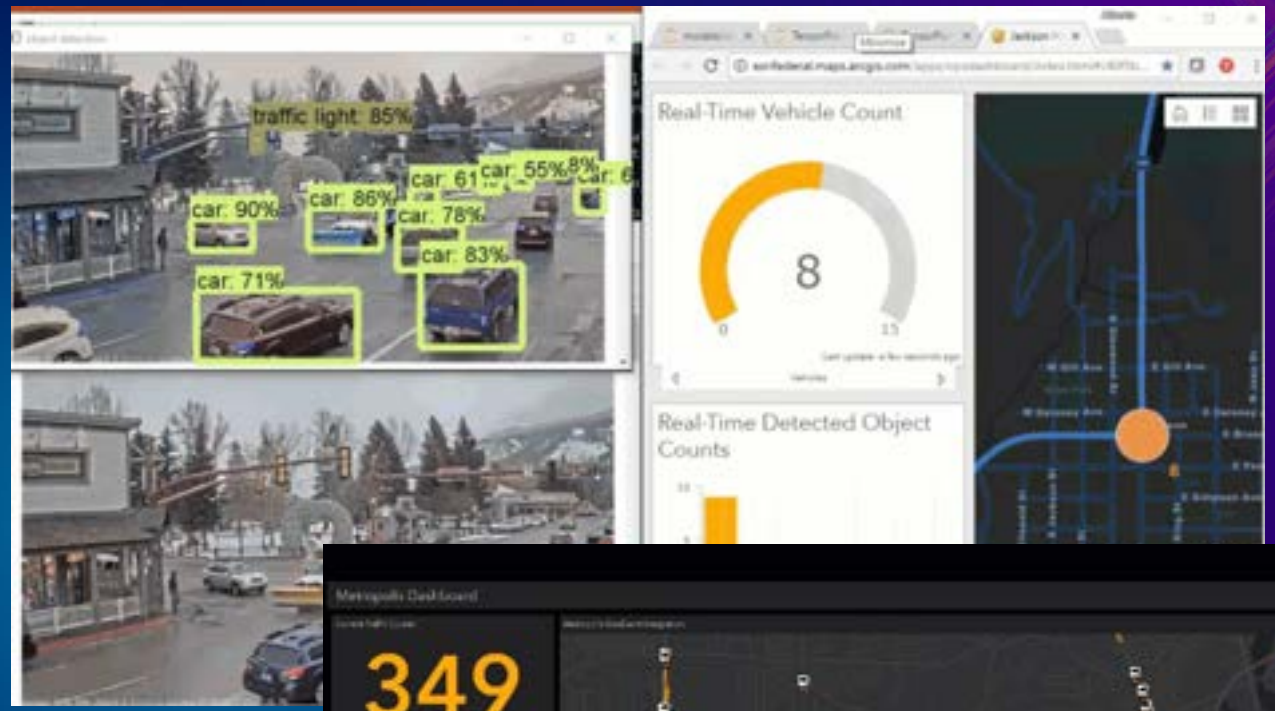
ArcGIS Pro for Intelligence

How Can We Use GeoAI in ArcGIS (Real-world examples)?

How Can We Use GeoAI in ArcGIS (Real-world examples)?

1. **Traffic Analysis from CCTVs**

   - Detect Vehicles by Type
   - Detect Pedestrians
   - Detect Accidents, Sudden Stops, or Other Anomalies
   - Understand Traffic Patterns
   - Deal with Incidents Quickly





How Can We Use GeoAI in ArcGIS (Real-world examples)?

2. **Road Crack Detection**

   - Automate Road Crack Detection for DOTs and Public Works
   - Determine type of crack and potentially length and width



How Can We Use GeoAI in ArcGIS (Real-world examples)?

3. Change Detection

Extract features from overhead imagery:

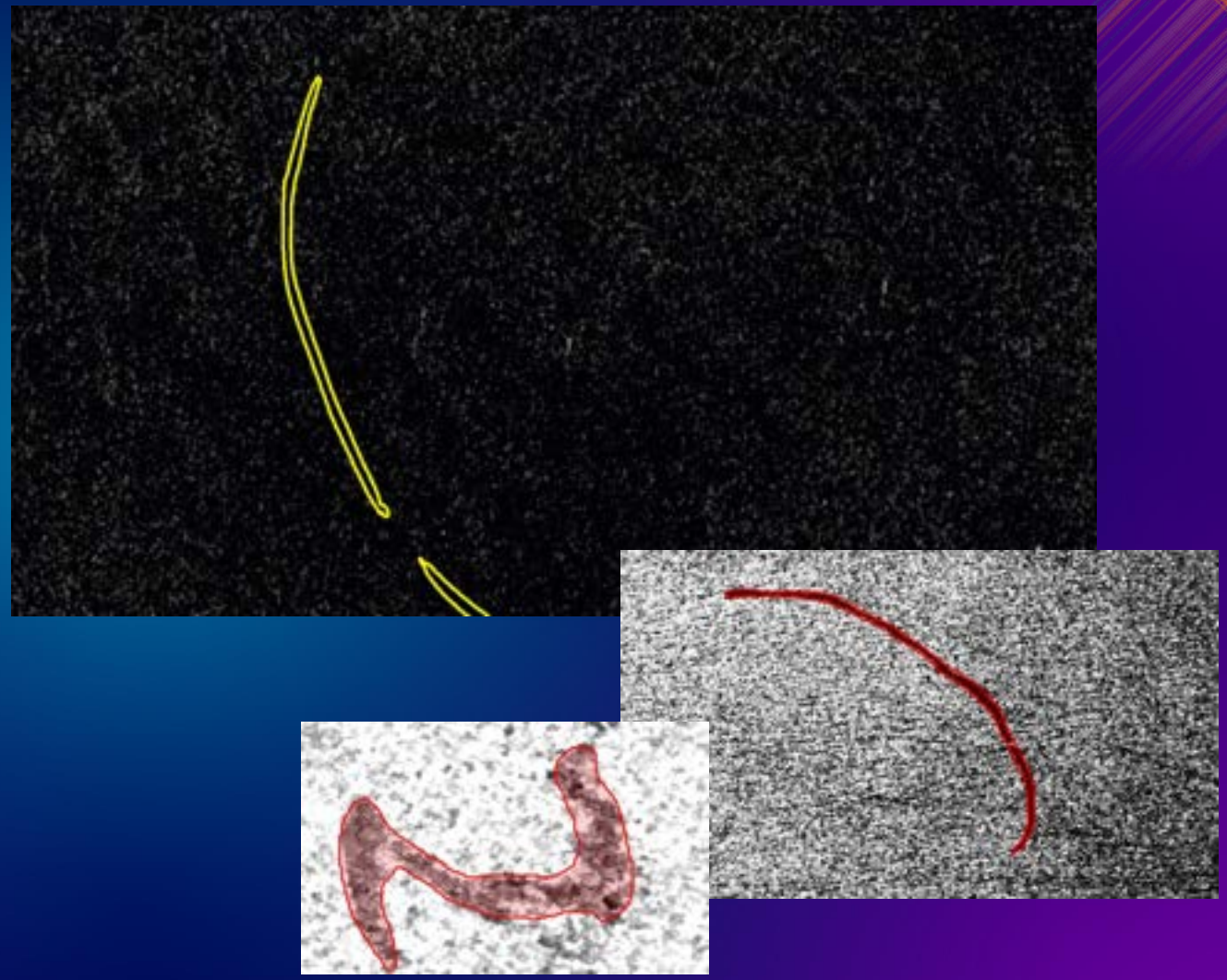
- Building Footprints
- Road Segments
- Parcel Boundaries
- Land Cover



How Can We Use GeoAI in ArcGIS (Real-world examples)?

4. **Oil Spill Detection (SAR)**

   - Operate in all weather conditions
   - Day and night monitoring
   - Detect oil spills from SAR data
   - Automate detection with deep learning
   - Reduce manual effort

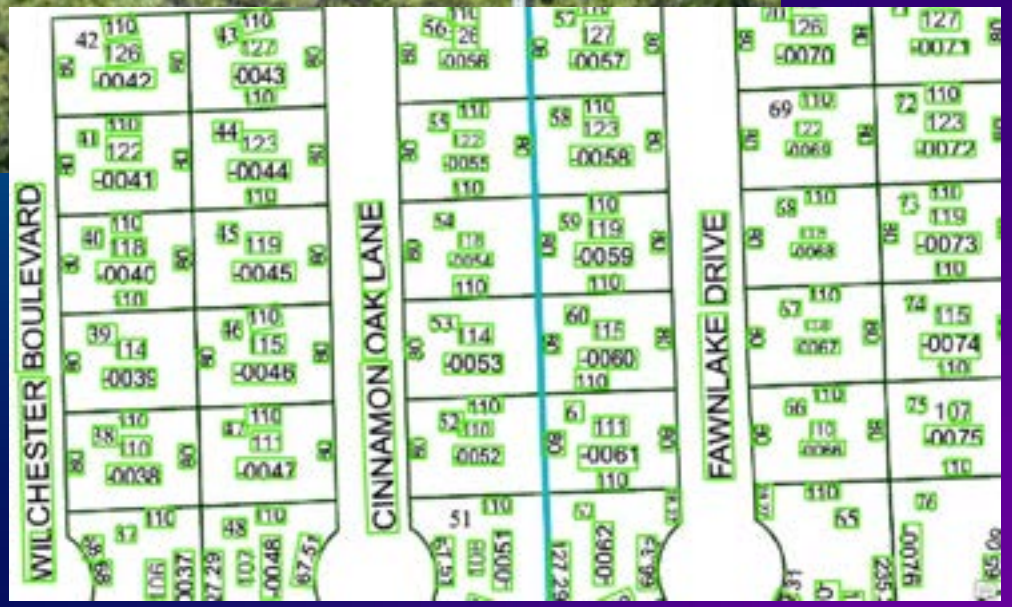


How Can We Use GeoAI in ArcGIS (Real-world examples)?

5. **Optical Character Recognition**

   - Detect text in natural scenes
   - Read text from road signs, billboards, and house numbers
   - Digitize scanned maps
   - Convert images with text to actionable data

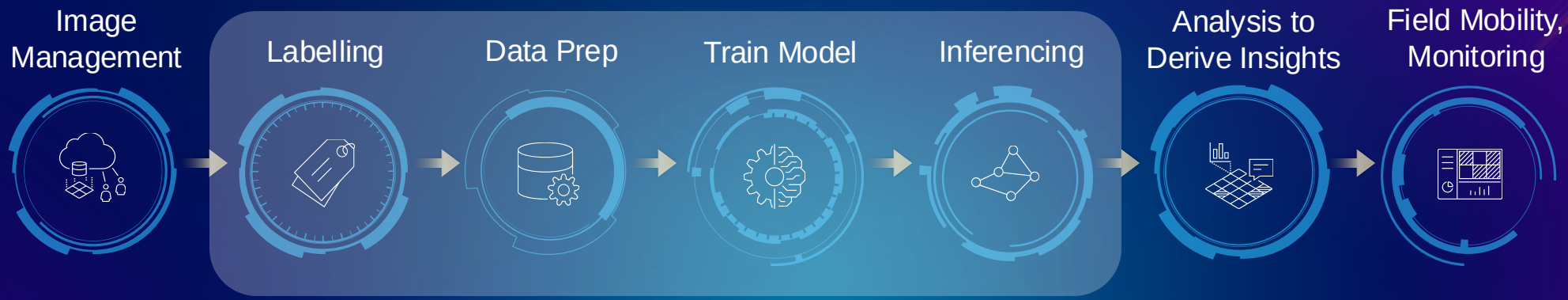




Machine Learning Lifecycle

GeoAI in ArcGIS – What's New

Productivity enhancements for deep learning

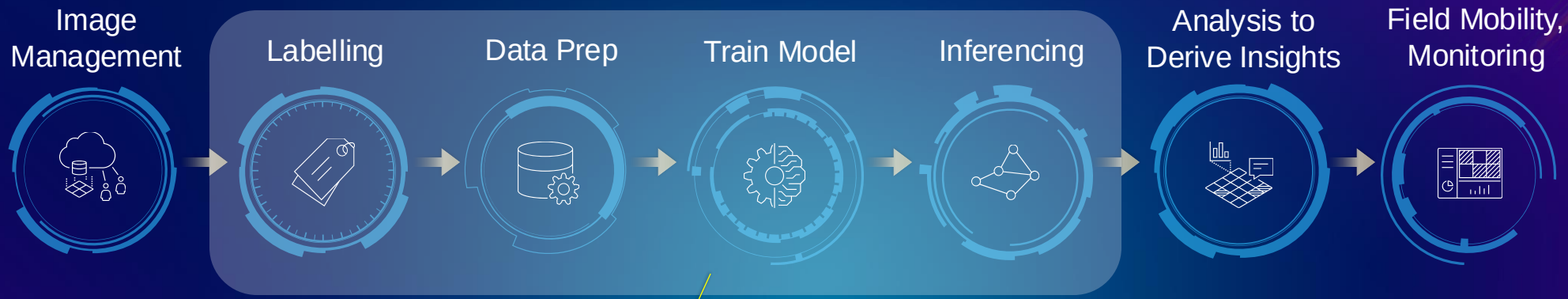


AI assisted labelling



GeoAI in ArcGIS – What's New

Productivity enhancements for deep learning

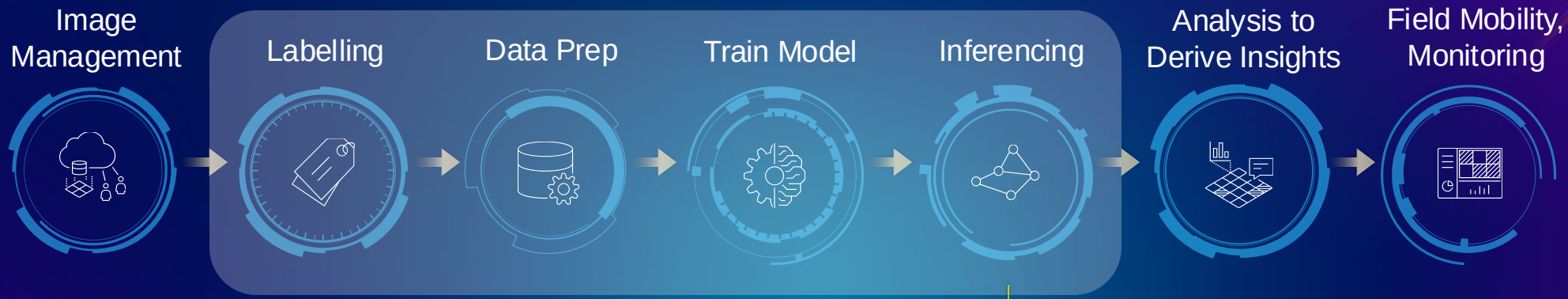


AutoDL



GeoAI in ArcGIS – What's New

Productivity enhancements for deep learning

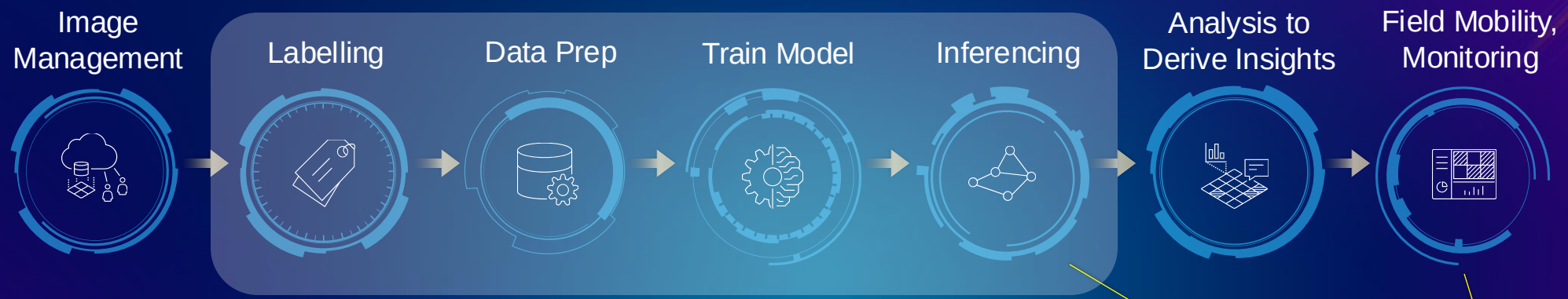


Multi-features extraction



GeoAI in ArcGIS – What's New

Productivity enhancements for deep learning

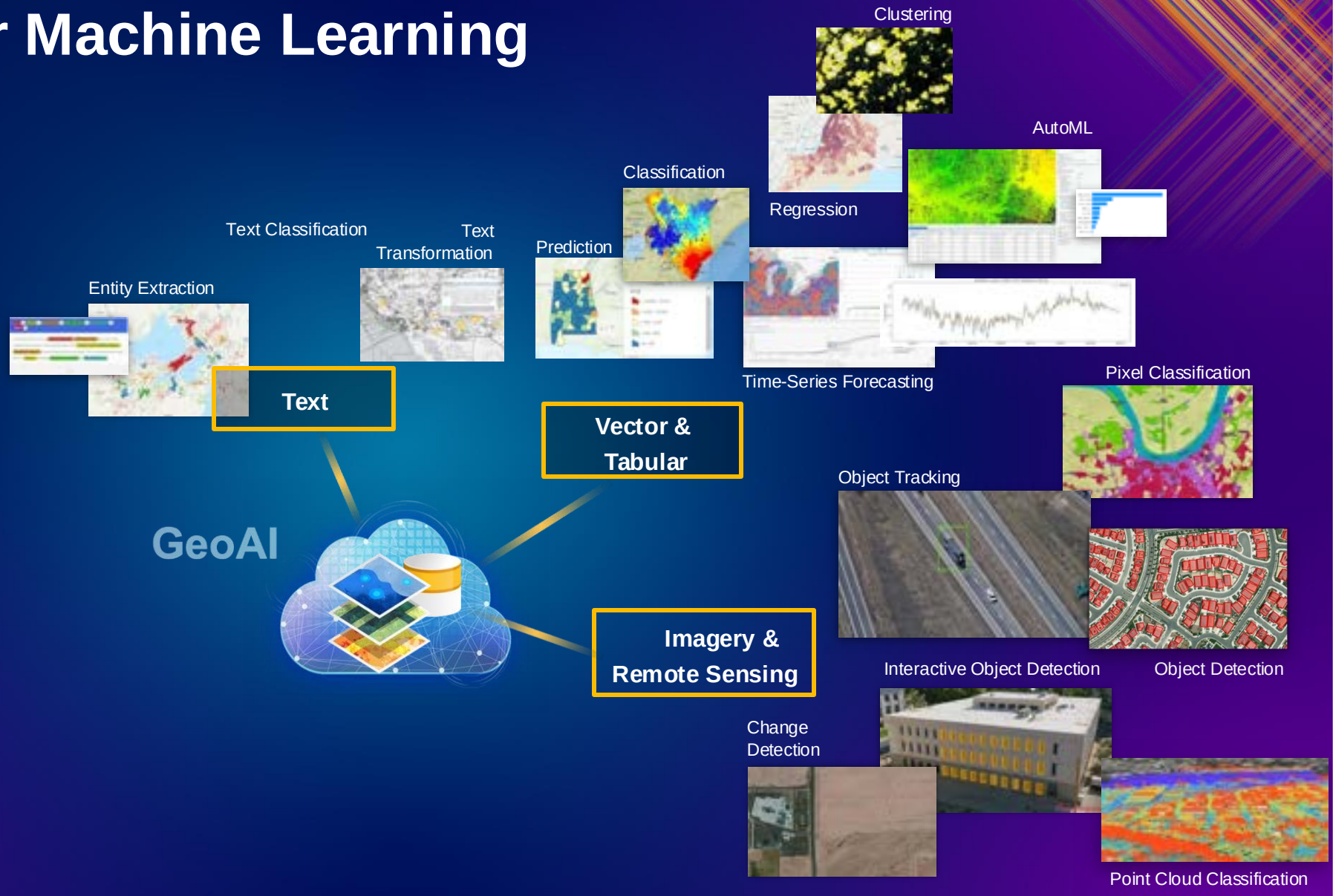


Inferencing using Survey123 (EfficientDet)



Data **Sources for Machine Learning**

Machine learning can work with various data types, each offering unique insights and opportunities. Let's explore four key data types:

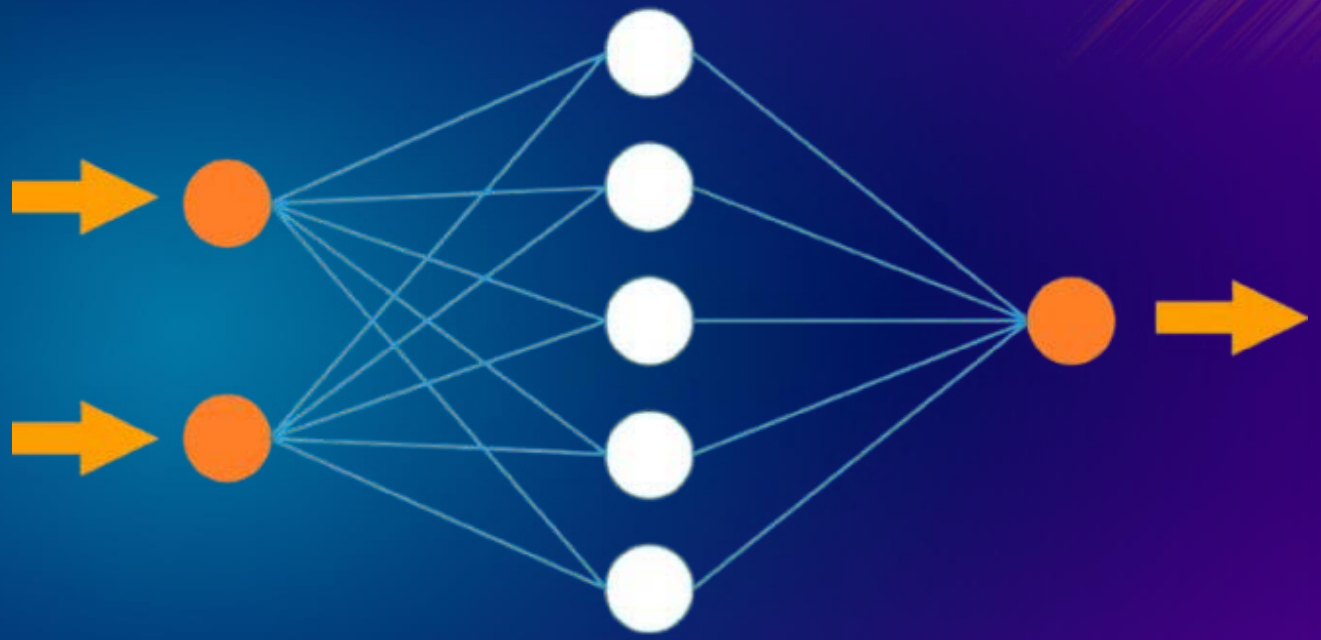


Accelerating intelligent decision-making

What is a Model in GeoAI?

In GeoAI, a model is a mathematical representation that learns patterns from data. It's trained to recognize specific features, make predictions, or extract insights based on the data it processes.

Models can be trained on geographic, imagery, text, or tabular data, and their applications span across fields like mapping, monitoring, and analysis.



Pre-Trained Models vs. Custom Models in GeoAI

Pretrained AI Models

Making AI approachable

Ideal for common use cases: object detection, classification, & clustering.

VS

Custom AI Models

Making AI your way

Flexibility to adapt to domain-specific challenges.

Pretrained AI Models

- Over 60+ pretrained models
  - Eliminate the need to develop and train models
  - Retrainable to your geography and imagery
  - **Available as part of the ArcGIS Living Atlas**

- Types of models
  - Image feature extraction and detection
  - Point cloud classification
  - Object tracking
  - Pixel classification
  - Image redaction



Pretrained AI Models

How it works?

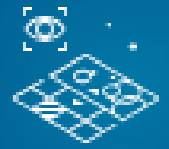
Step 1



Choose your tool

Open your ArcGIS client application and launch your tool of choice (e.g., detect objects, classify objects,).

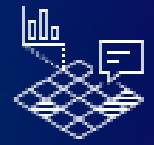
Step 2



Select your input

Point to the data from which you want to extract information.

Step 3

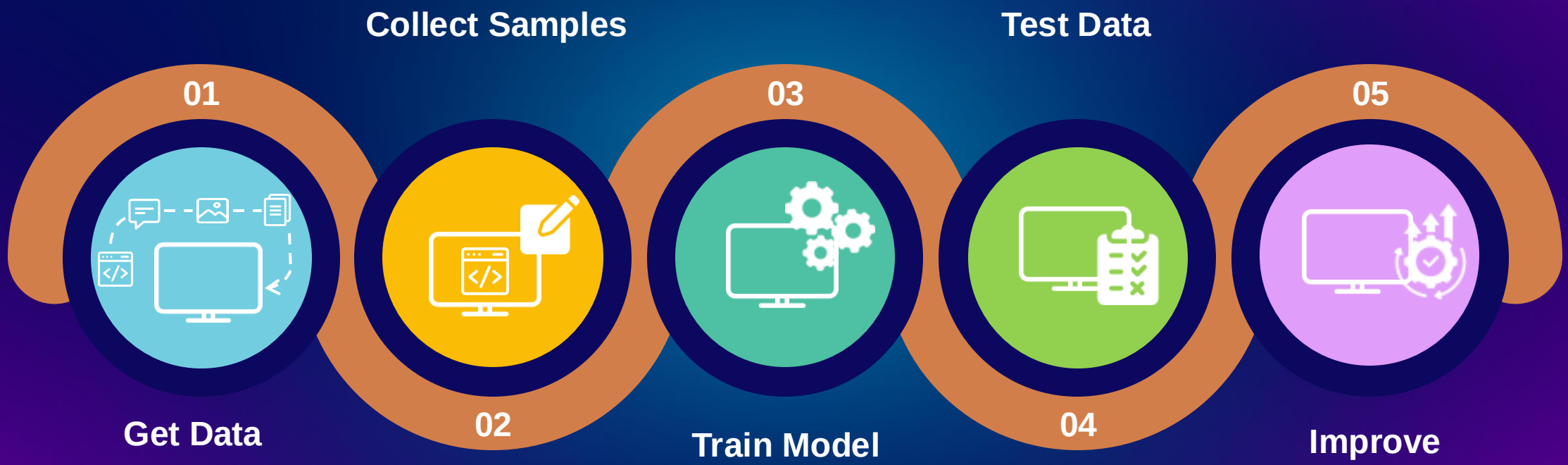


Extract

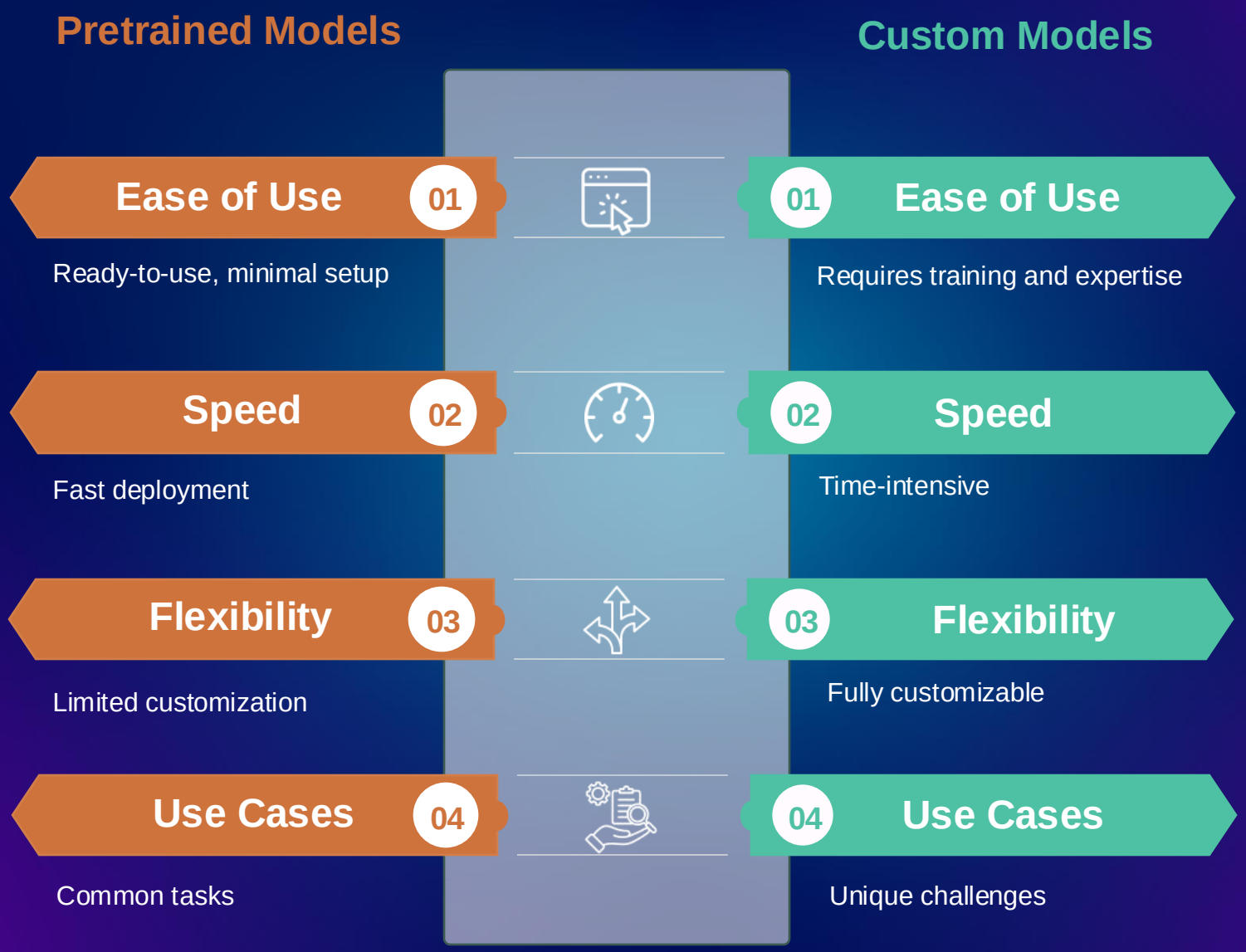
Browse for your desired pretrained deep learning model and run your analysis.

Custom AI Models

Creating a custom AI model involves tailoring solutions to your specific needs



Pretrained or Custom? The Choice is Yours!



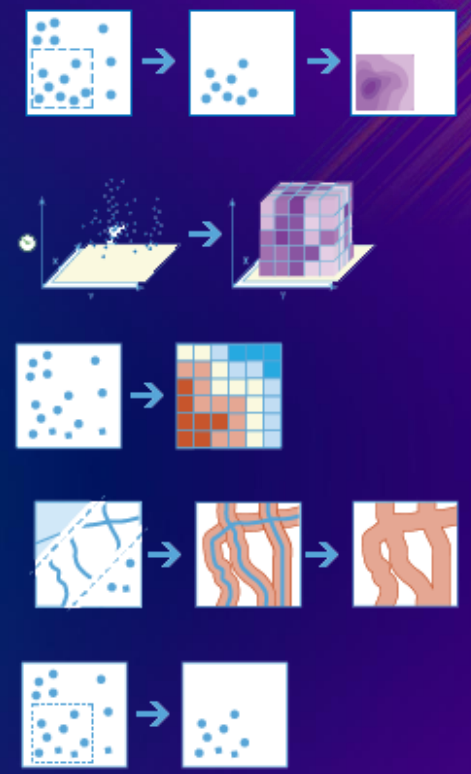
Machine Learning Tools in ArcGIS

- **Classification**
  - Maximum Likelihood Classification
  - Random Trees
  - Support Vector Machine

- **Clustering**
  - Spatially Constrained Multivariate Clustering
  - Multivariate Clustering
  - Density-based Clustering
  - Image Segmentation
  - Hot Spot Analysis
  - Cluster and Outlier Analysis
  - Space Time Pattern Mining



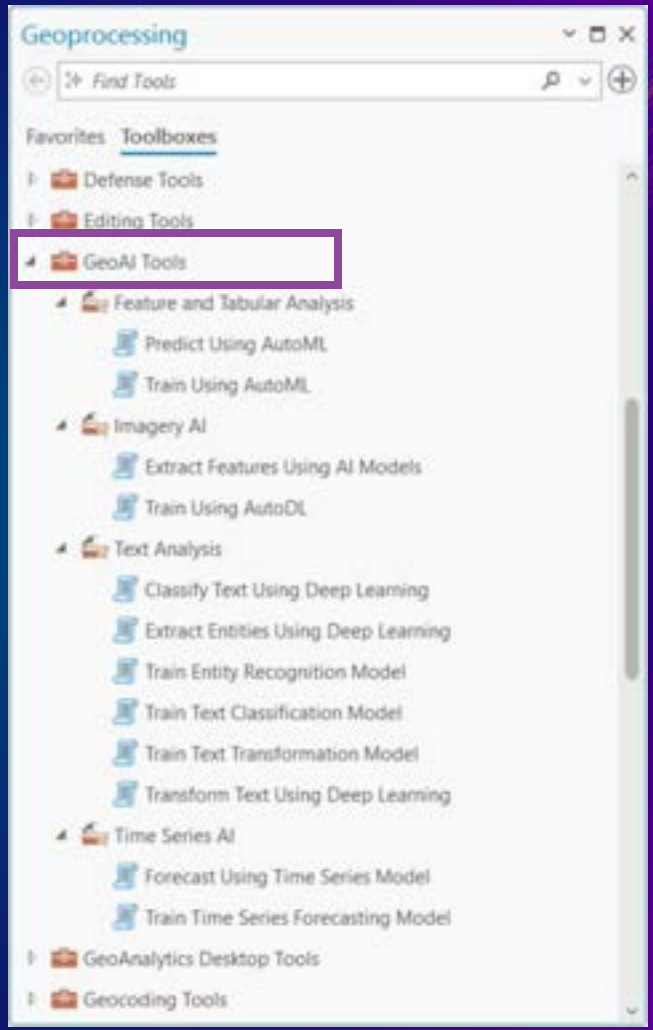
- **Prediction**
  - Empirical Bayesian Kriging
  - Areal Interpolation
  - EBK Regression Prediction
  - Ordinary Least Squares Regression and Exploratory Regression
  - Geographically Weighted Regression
  - Forest Based Prediction
  - Time Series Forecasting



GeoAI Toolbox Overview

The GeoAI toolbox in ArcGIS Pro combines AI with GIS to unlock powerful analysis tools:

- **Feature and Tabular Analysis:** contains tools for applying machine learning and deep learning algorithms to feature or tabular data.
- **Imagery Analysis:** contains tools that apply object detection and pixel classification deep learning algorithms to imagery data.
- **Text Analysis:** contains tools that perform natural language processing on text. Text can be classified or transformed, and entities such as addresses can be extracted.
- **Time Series Analysis:** contains tools that forecast and estimate future values at locations in a space-time cube.



Demos

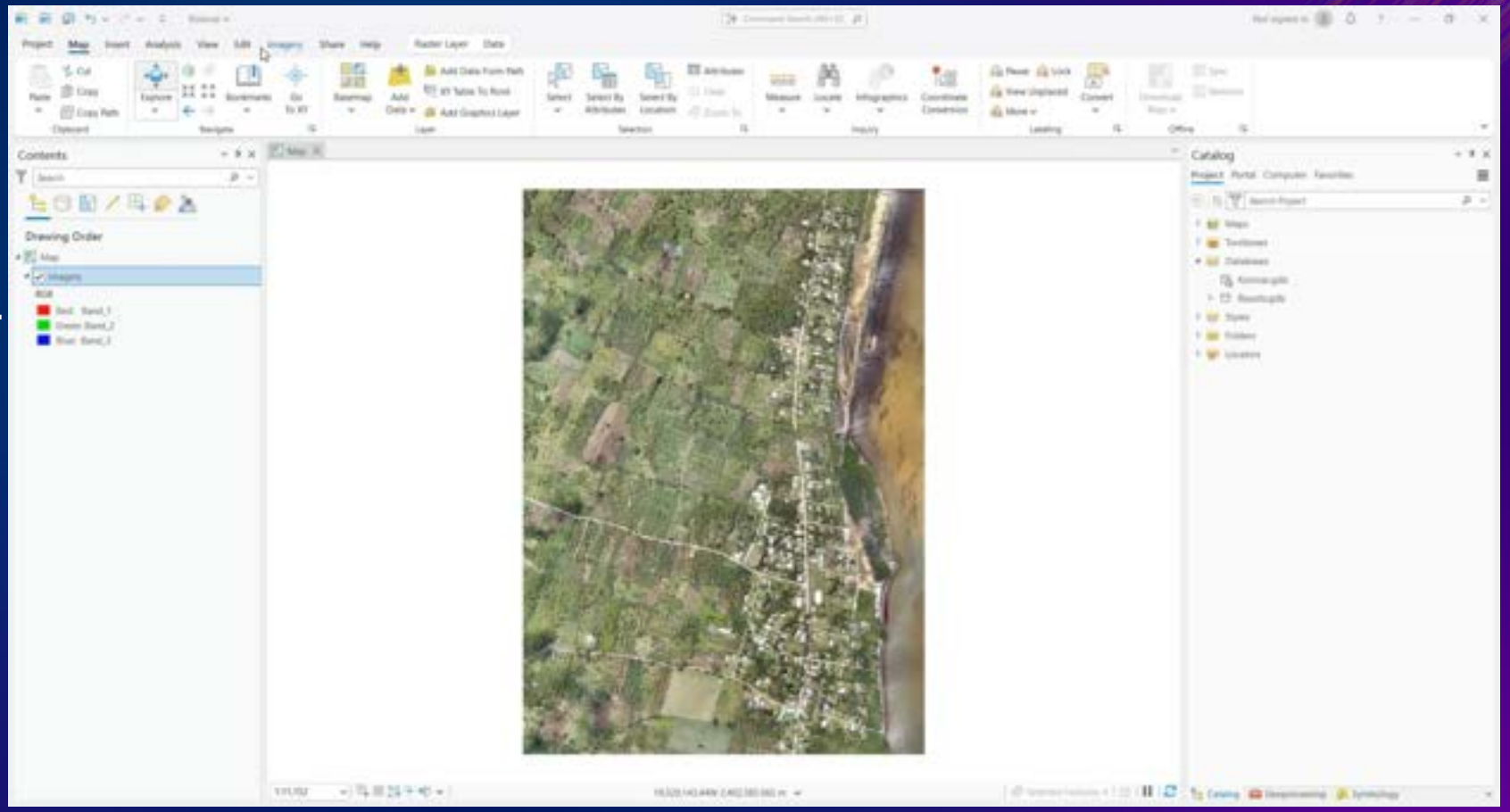


Demo 1: Custom AI Model Demo: Palm Tree Health Assessment

In this demo, we'll walk through the process of creating a custom AI model to assess the health of palm trees using ArcGIS.

Highlight key steps:

- Prepare training samples.
- Train the deep learning model.
- Test and apply the model.

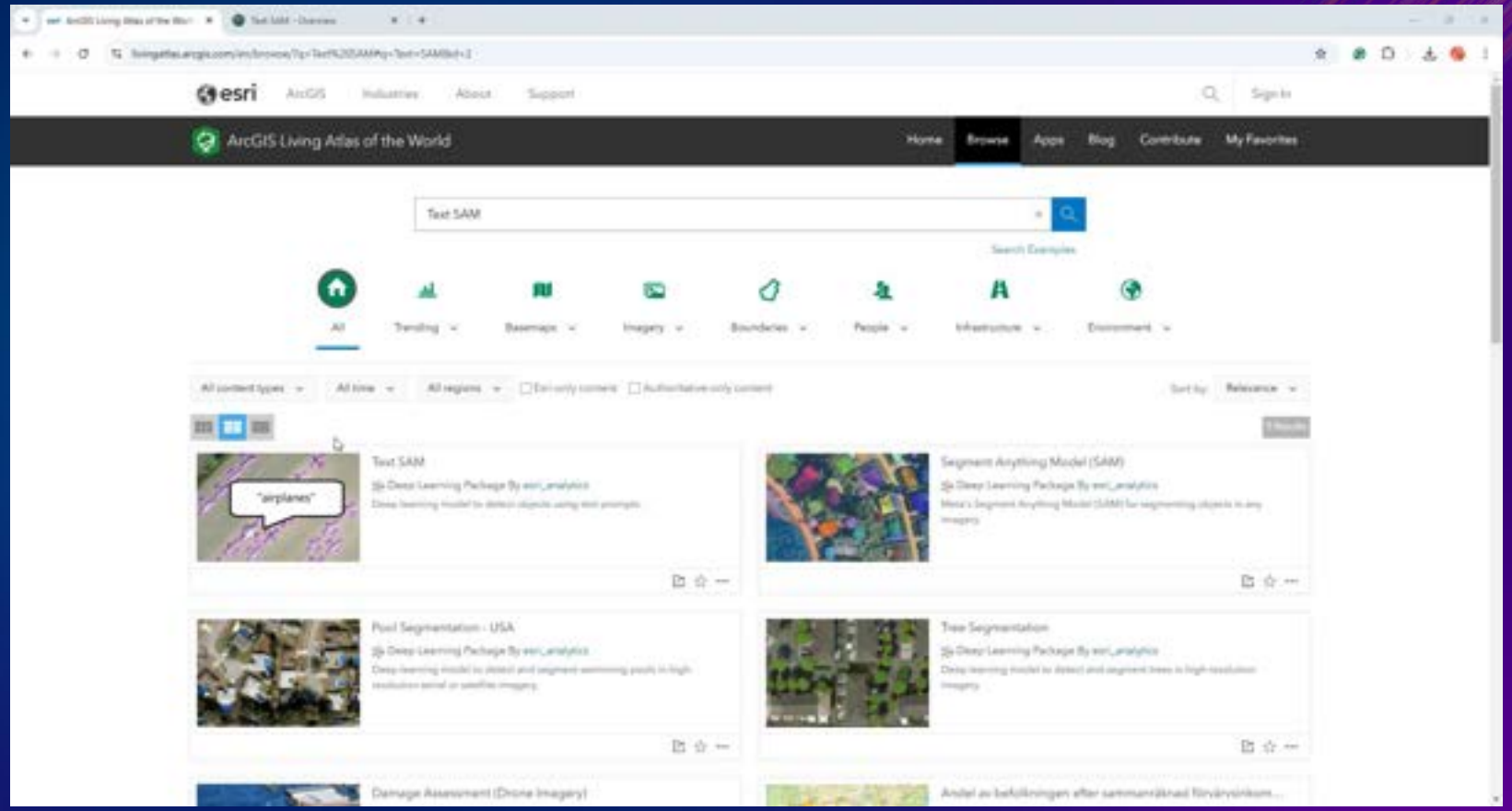


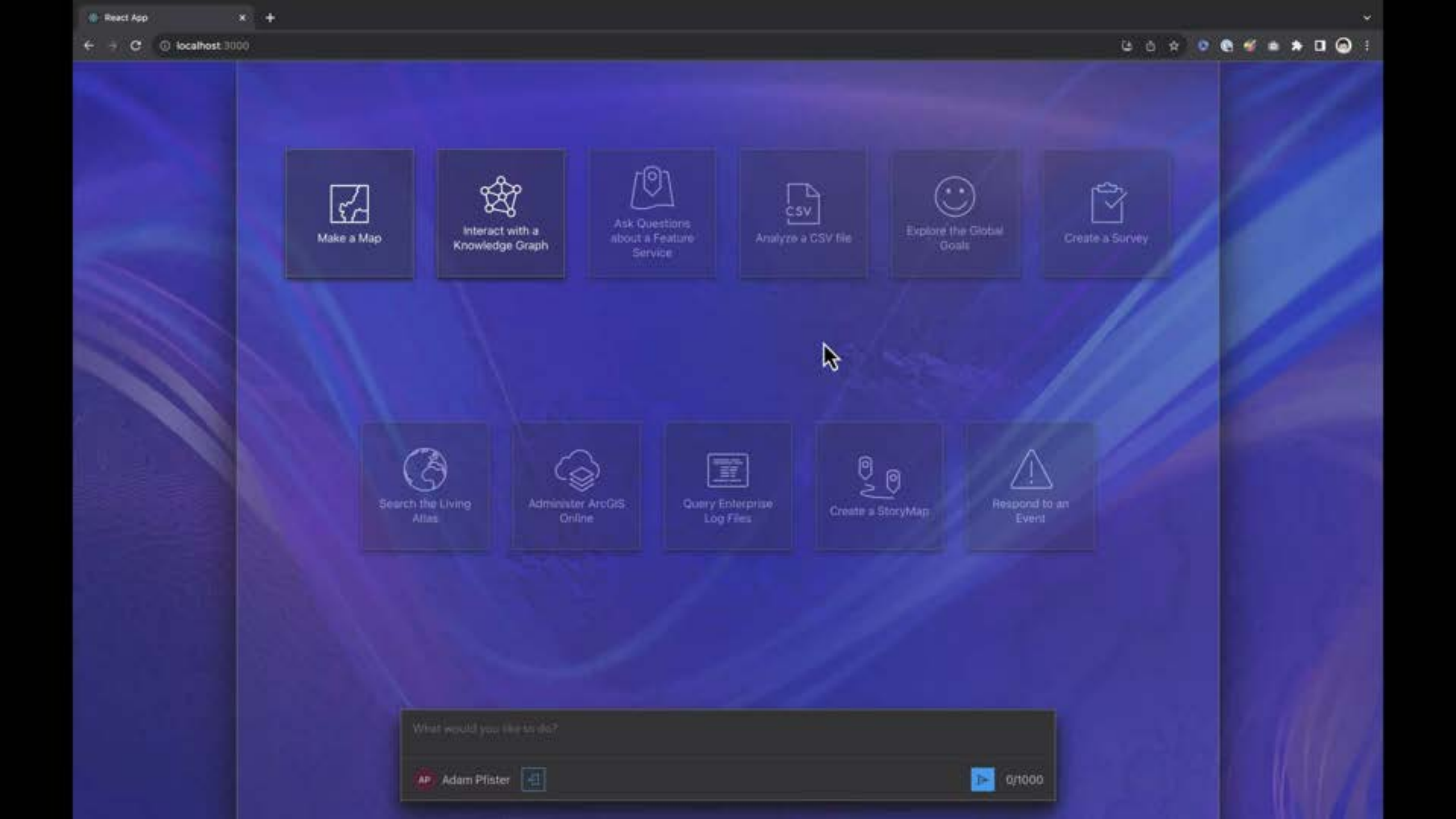
Demo 2: Detect objects with Text SAM

In this demo, we'll Use a multi-purpose GeoAI model with a free-form language prompt to detect boats in imagery.

Highlight key steps:

- Download the Text SAM model
- Detect Objects using Text SAM
- Style the result layer
- Refine the results




React App
localhost:3000
Make a Map
Interact with a Knowledge Graph
Ask Questions about a Feature Service
CSV
Analyze a CSV file
Explore the Global Goals
Create a Survey
Search the Living Atlas
Administer ArcGIS Online
Query Enterprise Log Files
Create a StoryMap
Respond to an Event
What would you like to do?
AP
Adam Pfister
0/1000



Cobb County

Crowd Detection for Event Management

SunTrustPark_OpsDashboard_Re
https://cobbcountyga.maps.arcgis.com/apps/opsdashboard/index.html#/fda008b4523d44c78e3673e8e8fd2e4d

ArcGIS and IBM Watson for Pedestrian Activity Detection

SunTrust Park
Traffic Operations Center

4:00 6 12 18 24 4:30 36 42 48 54

Time Selection

4:00pm to

Pedestrian Flow
SunTrust Park to Parking Lot

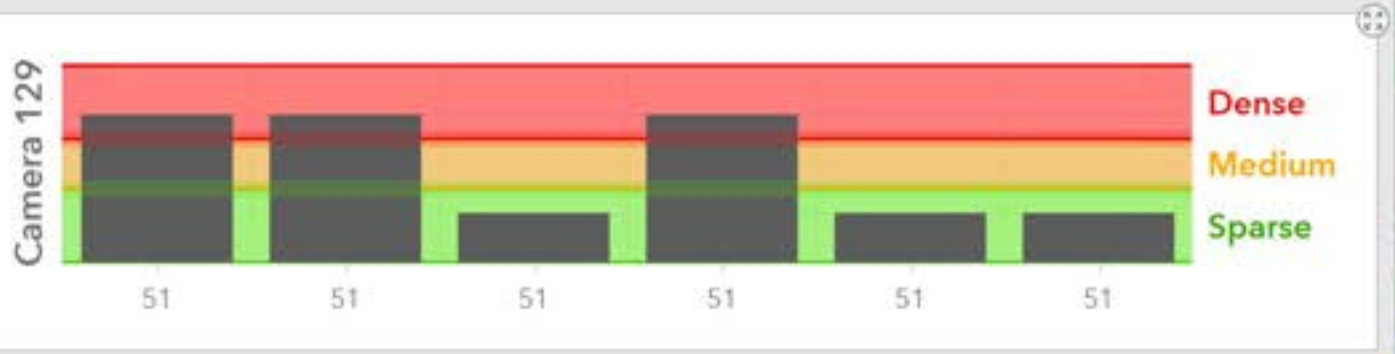
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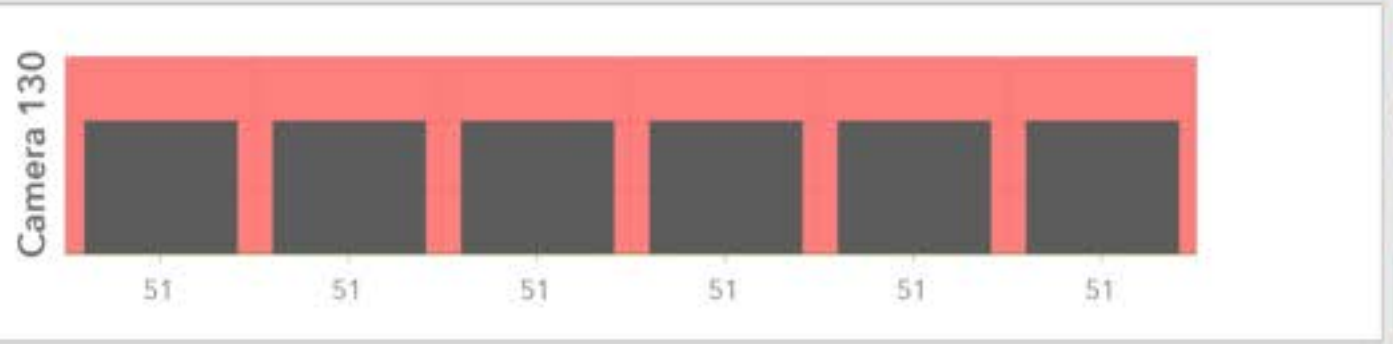
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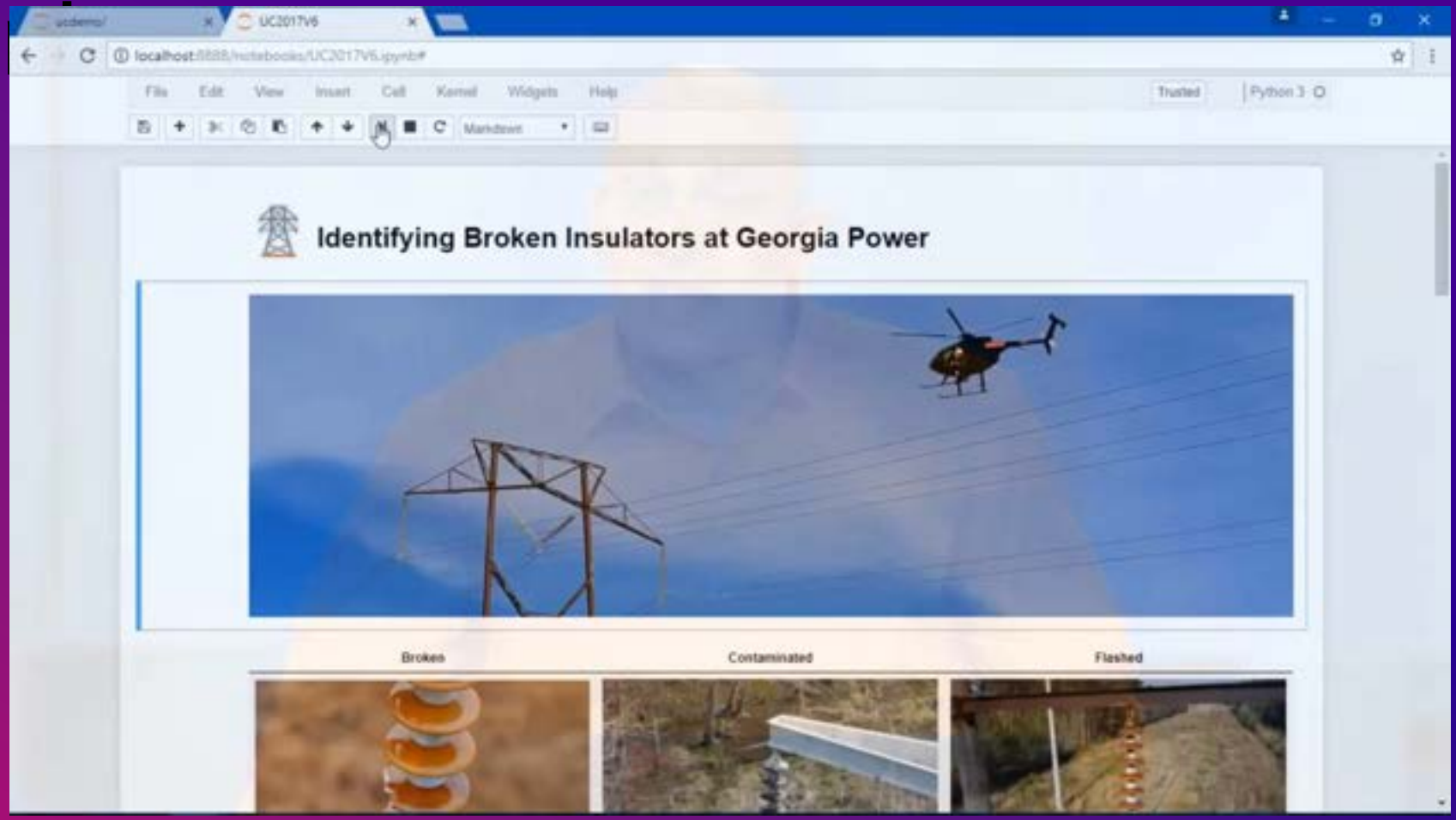
Advanced Object Detection from Imagery

Discover Deep Hidden Insights from Imagery Data

Vehicle Tracking using Deep Learning with Pro



Identifying Broken Insulators via Deep Lear



AI Assistants in ArcGIS

AI Assistants in ArcGIS: Enhancing User Experience

AI is transforming ArcGIS, making tasks easier with:



Automate repetitive tasks in ArcGIS tools.

- **ArcGIS Survey123 (Beta):** Conversational survey design.
- **ArcGIS Pro:** Assistance with SQL, Python, Cypher, and Arcade expressions.
- **ArcGIS Business Analyst:** Market planning and site selection.



Broader AI tools designed to answer geospatial questions and support entire workflows.

Example: A public-facing assistant in ArcGIS Hub for interpreting queries and providing accurate data.

Advancing AI Responsibly

Esri is committed to developing AI tools in GIS with a focus on **Accuracy**, **Transparency**, and **Ethical** practices.

Leveraging AI and geography to solve global challenges.



Guided by Esri's AI Advisory Board for ethical implementation.

Use inputs from trusted sources. Build safeguards to reduce risks.

High-quality data and metadata drive AI progress.


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