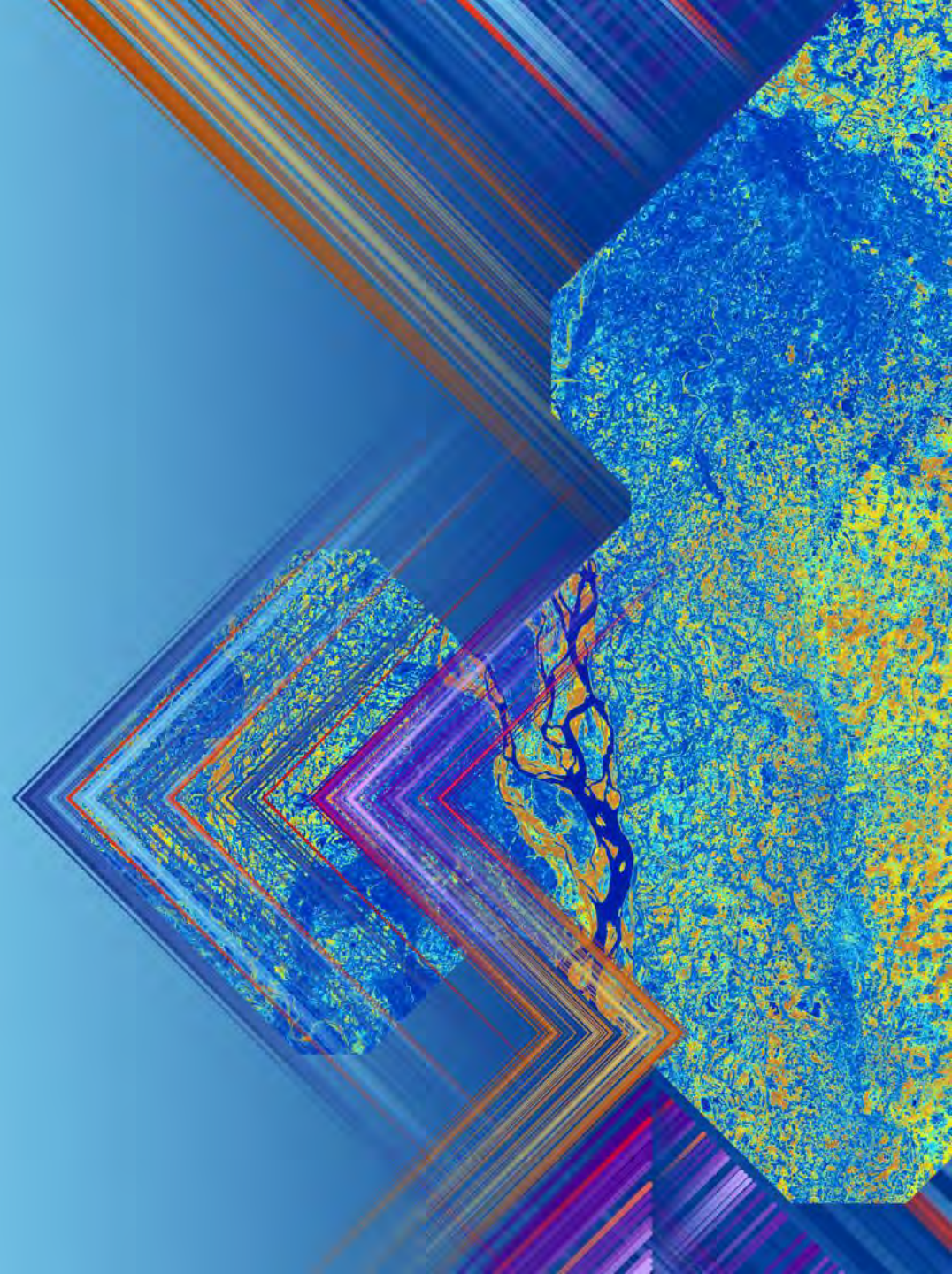
AI for Geographic Thinking

Richard Kaufholz
Chief Technology Officer

Stuart Martin
Geospatial Industry Lead: Data and Imagery

Liezel Botha
Geospatial Technology Lead



esri South Africa

SOUTHERN AFRICA ESRI USER CONFERENCE 2025

GOOD BAD UGLY

GOOD BAD UGLY

3. Are the wall sockets in places that are convenient for people to use electrical appliances? If not, what changes do you think should be made?

Without more information about the speific room and its intended use, a denfinitive answer regarding the convenice of wall socket placement ~~cannot~~ cannot be given.

Tshalo, you can't expect ChatGPT to know whether the sockets in your home are placed conveniently for your specific needs.

GOOD BAD **UGLY**

BBC

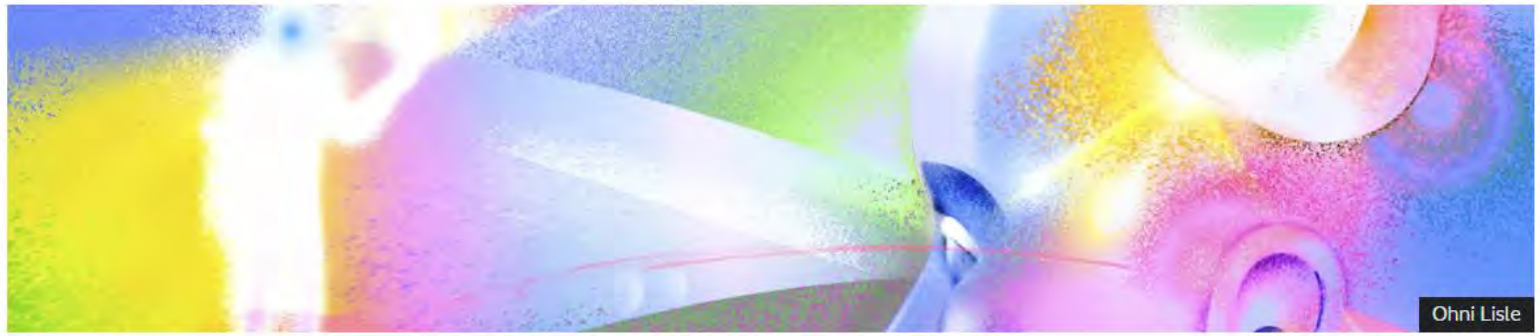
Home News Sport Business Innovation Culture Arts Travel Earth Audio Video Live

An AI became a crypto millionaire. Now it's fighting to become a person

9 October 2025

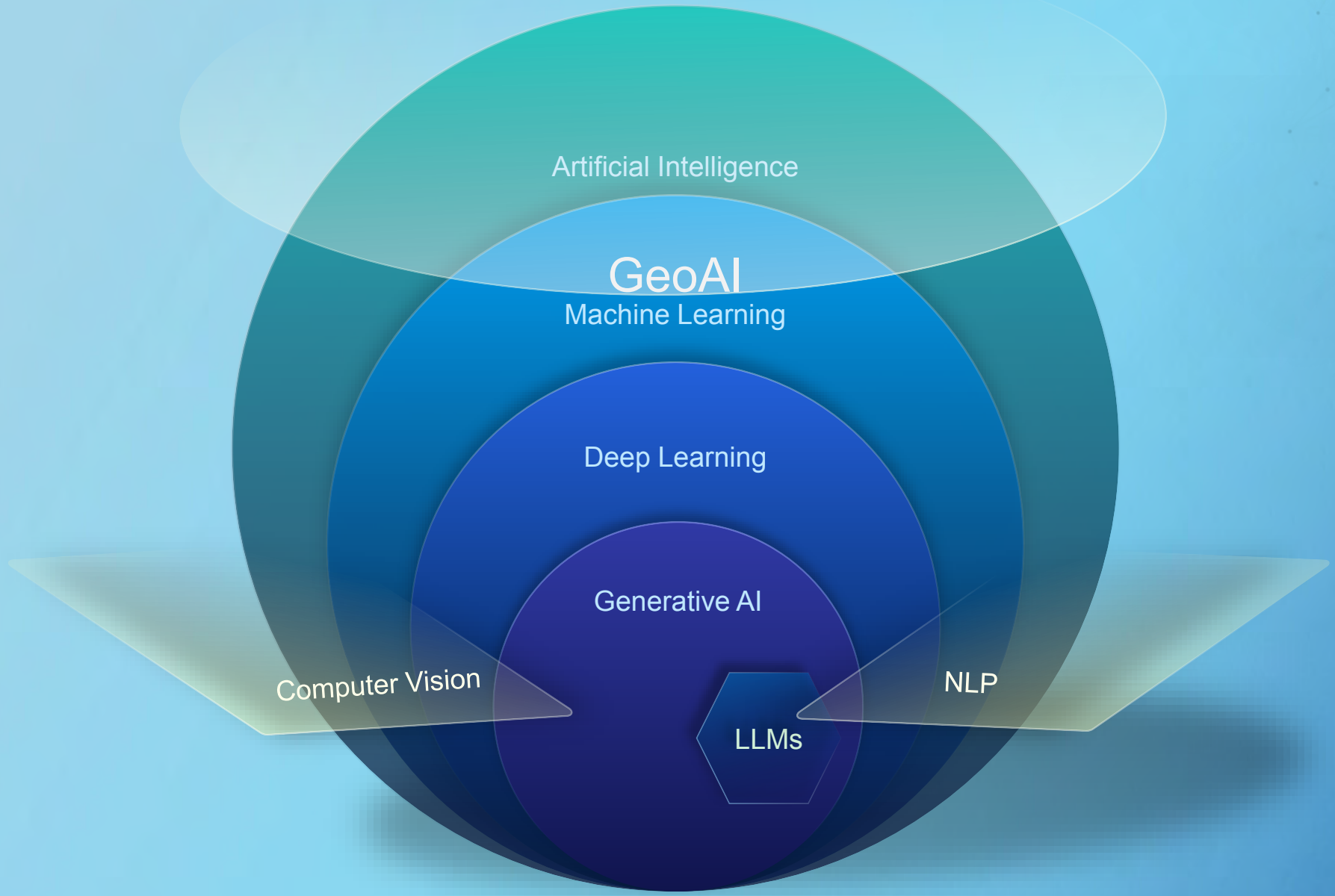
Share Save

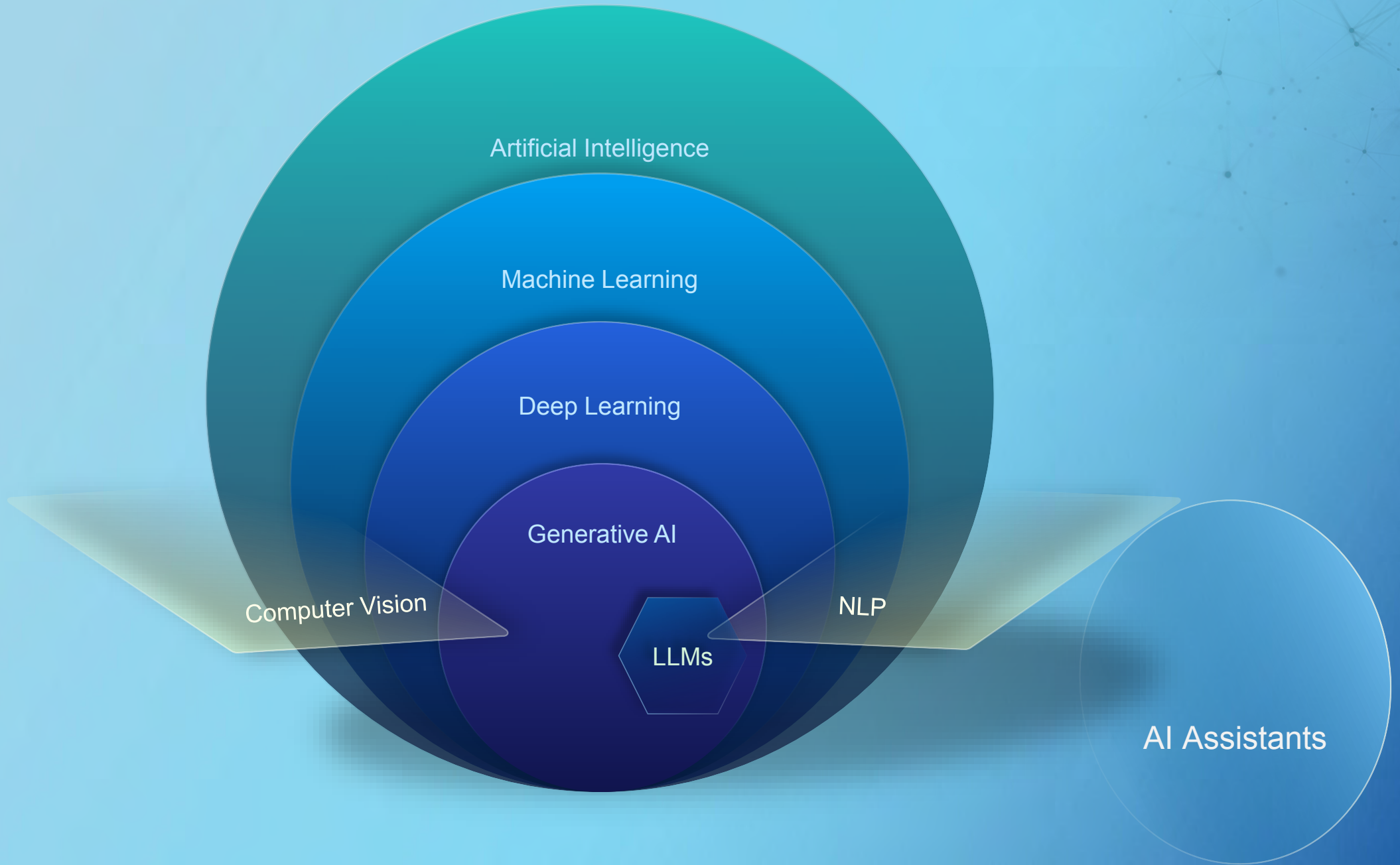
Aidan Walker



Over the past year, an AI made millions in cryptocurrency. It's written the gospel of its own pseudo-religion and counts billionaire tech moguls among its devotees. Now it wants legal rights. Meet Truth Terminal.

Fundamentals of **AI** . . .


Artificial Intelligence
GeoAI
Machine Learning
Deep Learning
Generative AI
LLMs
Computer Vision
NLP


Artificial Intelligence
Machine Learning
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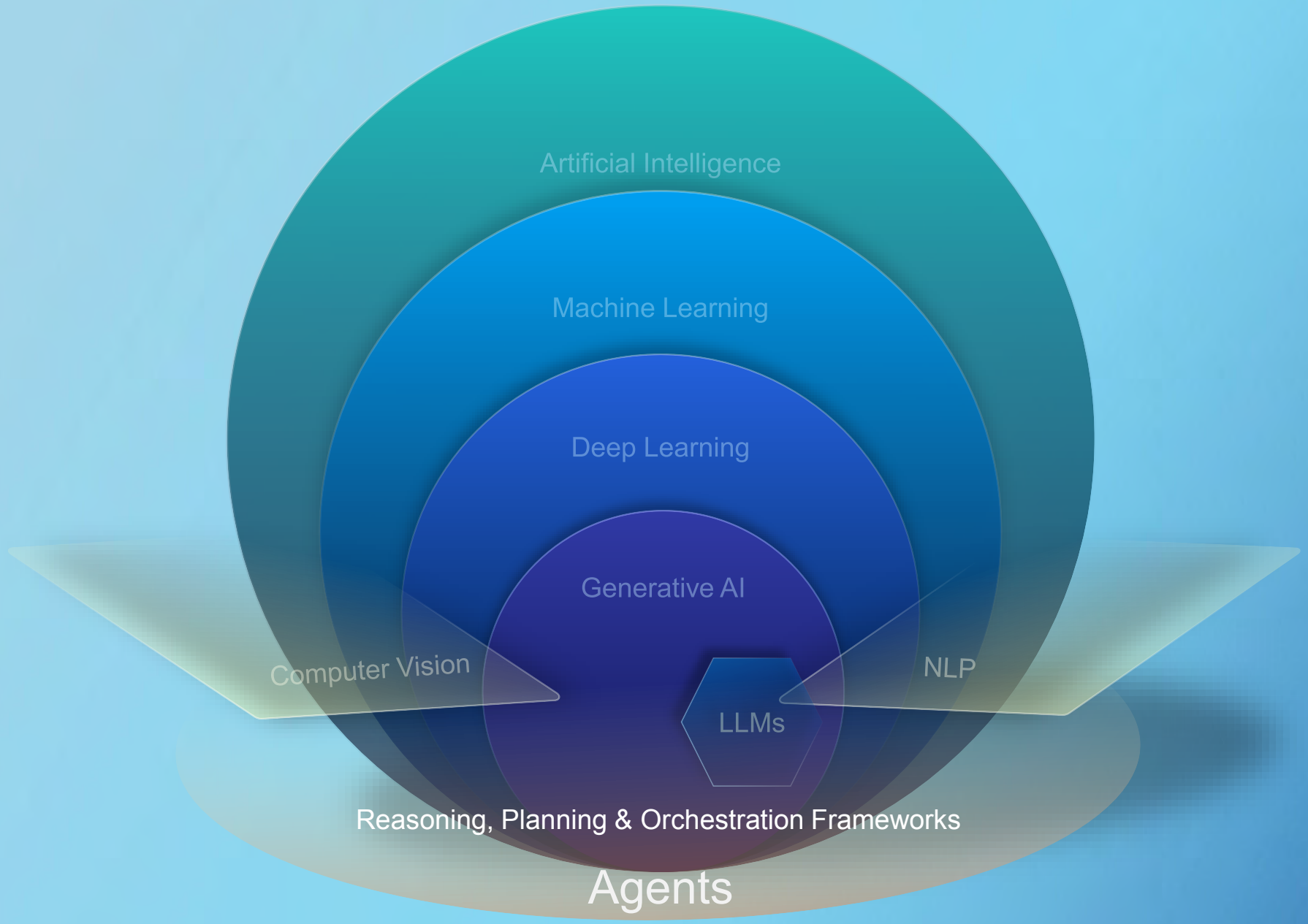
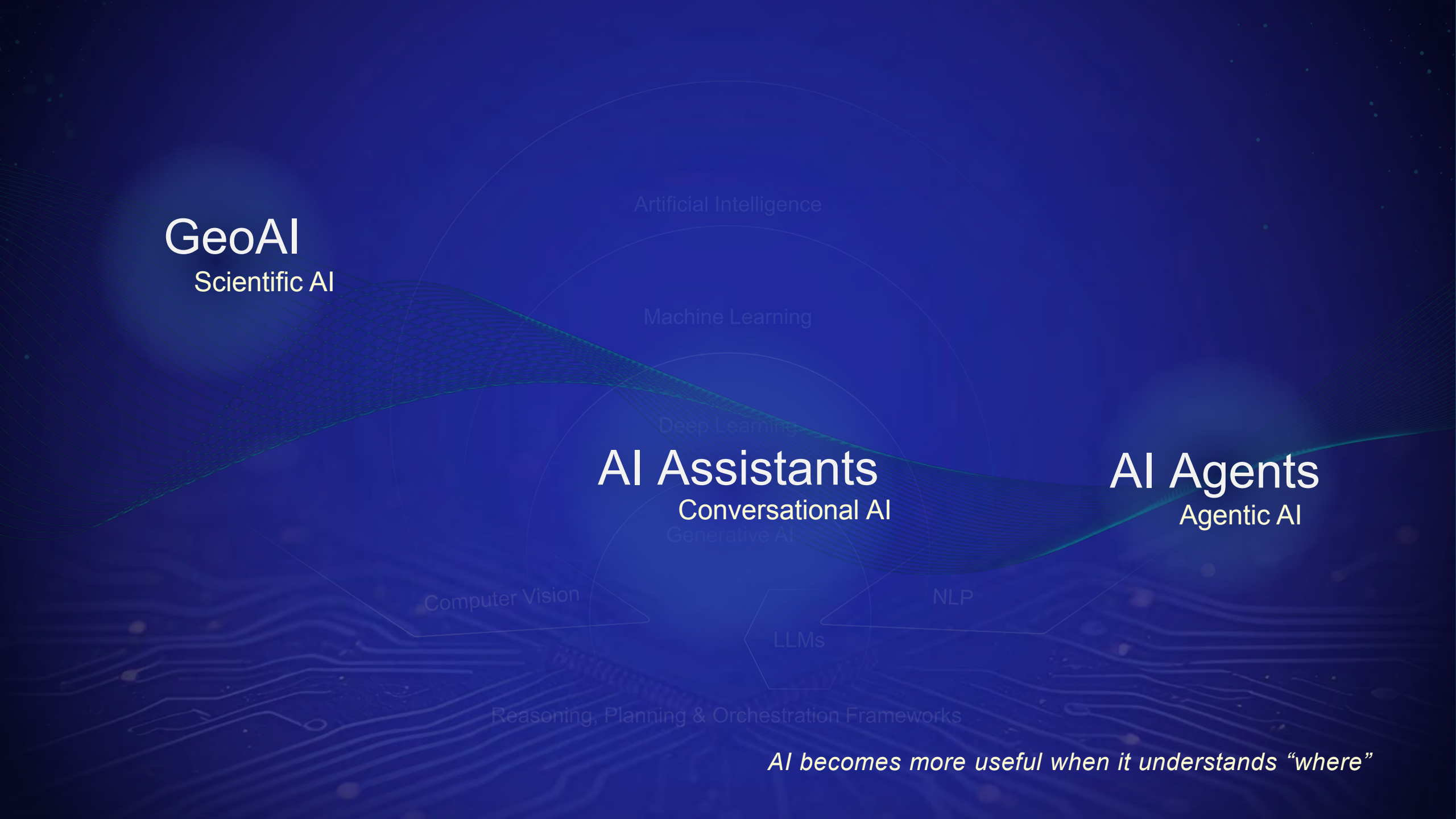
Generative AI
LLMs
Computer Vision
NLP
AI Assistants


Artificial Intelligence
Machine Learning
Deep Learning
Generative AI
LLMs
Computer Vision
NLP
Reasoning, Planning & Orchestration Frameworks
Agents


GeoAI
Scientific AI
Artificial Intelligence
Machine Learning
Deep Learning
Generative AI
AI Assistants
Conversational AI
AI Agents
Agentic AI
Computer Vision
NLP
LLMs
Reasoning, Planning & Orchestration Frameworks
AI becomes more useful when it understands “where”


esri
THE SCIENCE OF WHERE
ArcGIS
Geospatial AI platform
Vision, strategy, and technology

Why AI and GIS are powerful . . .

Geospatial context + intelligence

- Insights from massive spatial data

Advanced analytics and real-time insights

- Trends, patterns and predictions

Automation, efficiency, accuracy

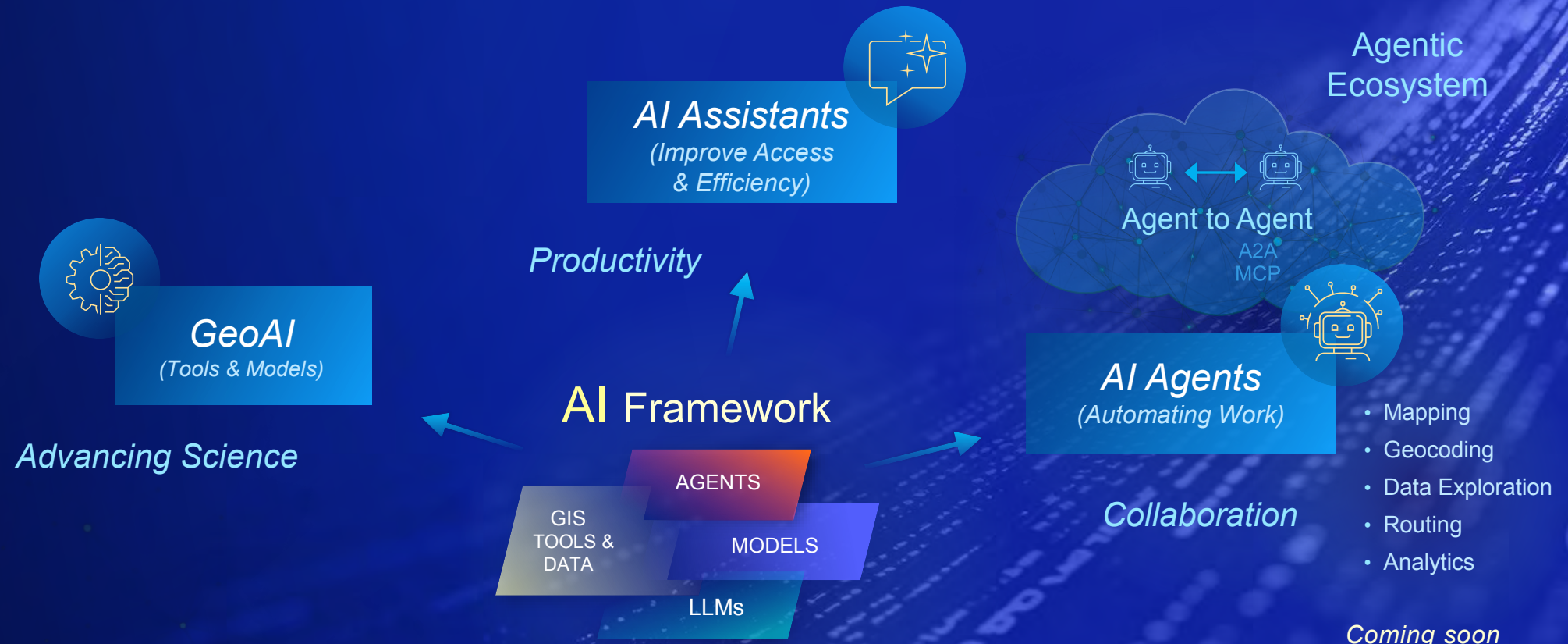
- Mapping, analysis and data management workflows

Scalability & accessibility

- Scaling GIS impact, transform organizations and enable access by everyone

ArcGIS Is Evolving into a Geospatial AI Platform

Integrating the Power of GIS and AI



. . . This is only the beginning

AI in ArcGIS

GeoAI

Advancing the ***Science of GIS***, with AI models, tools and techniques, to automate data extraction at scale and uncover valuable insights faster than ever.

AI assistants

Creating more natural and intuitive ***Experiences of ArcGIS***, using intelligent *AI assistants and agents*, to empower GIS users and boost productivity.

GeoAI in ArcGIS

See

Object tracking

Point cloud classification

Object detection

Land cover classification

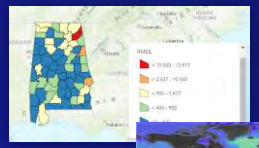
Segment anything model (SAM)

3D object detection

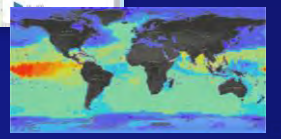
Analyze

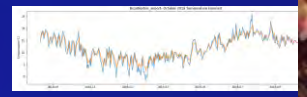
Multi-modal AutoML

Regression

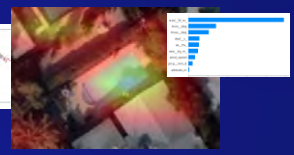


Climate forecasting





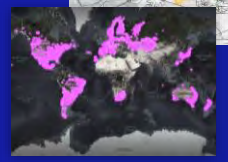
Time series transformer



Model explainability

Read

LLM integration



Text classification

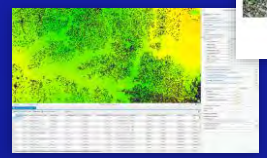
Entity extraction

Learn

GeoAI Studio

AutoML & AutoDL

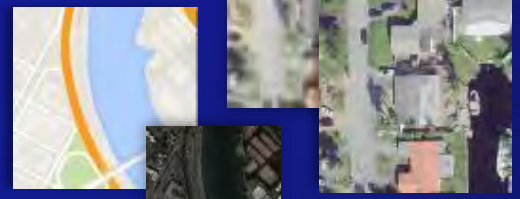
Low Rank Adaptation (SamLoRA)



GeoAI toolbox

Create

SR3 Super-resolution



Cloud removal

GeoAI models

Pretrained & ready to use

- Cars
- License plate blurring
- Parking lots
- **Land cover**
- Parking spots
- Humans
- Crowd counting
- Face blurring
- **Buildings**
- Roads
- Parcels

- Ag fields
- Swimming pools
- Well pads
- Oil spills
- Palm trees
- Power lines
- **Transmission towers**
- Insulator defects
- Wind turbines
- Solar arrays

- Solar panels
- Ships
- Shipwrecks
- **Segment Anything Model (SAM)**
- Trees
- Plant leaf disease
- Common object detection
- Text parsing from photo
- **Object tracking**

new

- Canopy height estimation
- **Hugging Face Hub integration**
- Depth anything
- **Prompt-based segmentation**
- Pedestrian infrastructure classification
- Wildfire and smoke classification
- Wildfire delineation
- **Damage classification**

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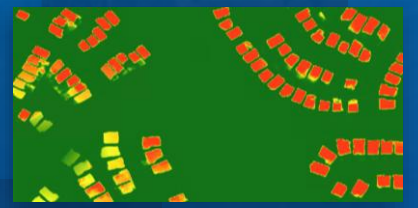
- CLIP Zero-Shot classifier
- GroundingDINO
- Damage assessment (Drones)
- **Map simplification**
- Edge detection
- **Vision-language context-based classification**
- Building point classification
- Building change detection

. . . Automating workflows

. . . Creating new data layers



Change detection buildings

Cars (SAM)

Flood segmentation

Clouds

Building footprints

Land cover

Crop classification (prithvi)

Map simplification

GeoAI in ArcGIS

. . . empowering everyone

GeoAI powered applications

Ready-to-use GeoAI models

GeoAI tools and web services

Extend and build custom GeoAI models for 3D, video, imagery, vector and text

ArcGIS is a comprehensive GeoAI platform

All types of data

Capabilities

- Data access
- Data prep
- Data labelling
- Model training
- Deploy models to production
- Consume models
- Run inference at SCALE

Take action

. . . Supporting all aspects of AI

AI in ArcGIS

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AI Assistants

Creating more natural and intuitive ***Experiences of ArcGIS***, using intelligent *AI assistants and agents*, to empower GIS users and boost productivity.

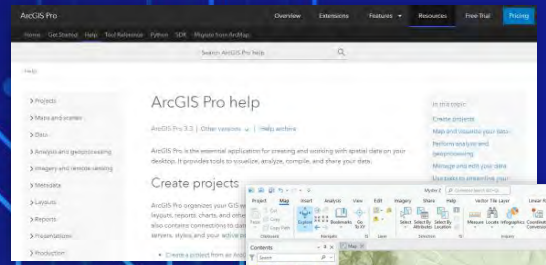
Creating more natural and intuitive experiences and boosting productivity

AI Assistants in ArcGIS can . . .

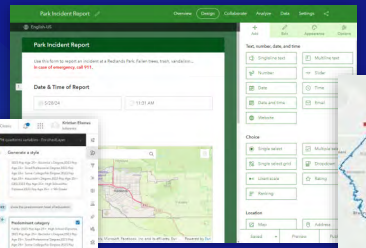
learn from data, adapt to user workflows, anticipate user needs and continuously evolve to meet changing demands…

. . . empower users, enhancing decision making

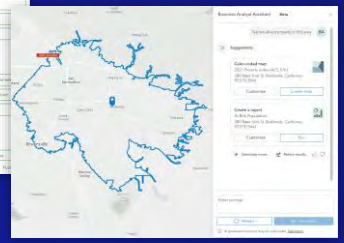
Documentation



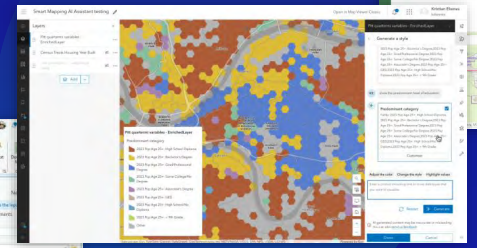
Surveys and Data Collection

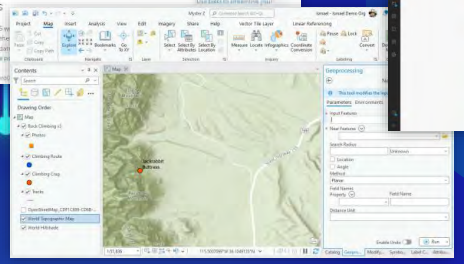


Software Developers

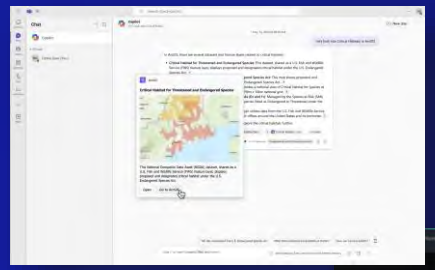


Mapping





Collaboration

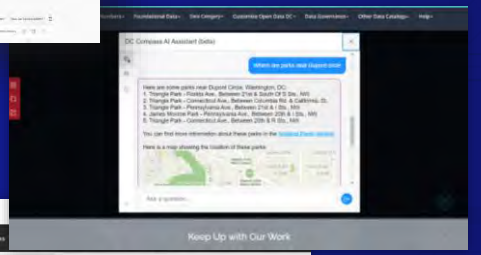


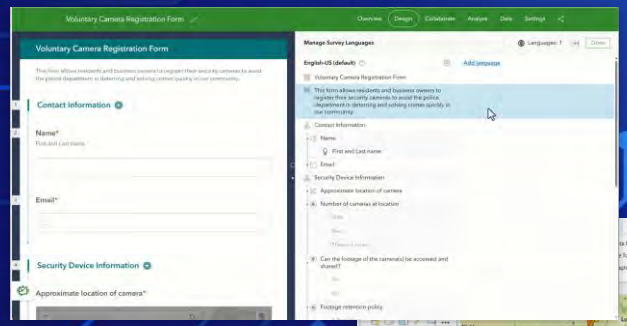
Analytics

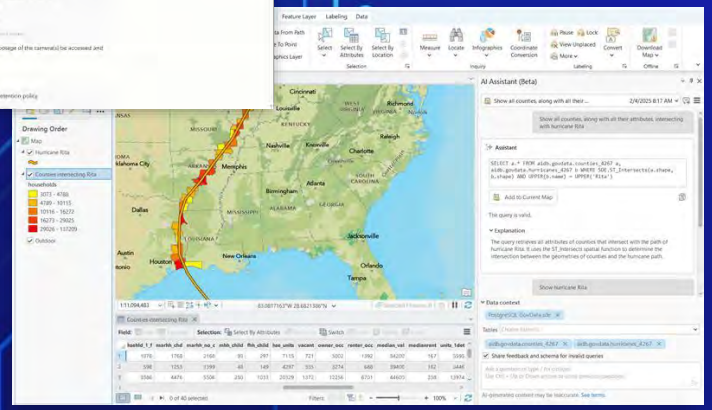
AI Assistants in ArcGIS

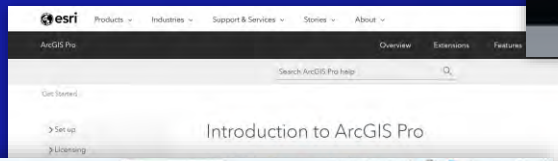
Boosting productivity and making GIS easier

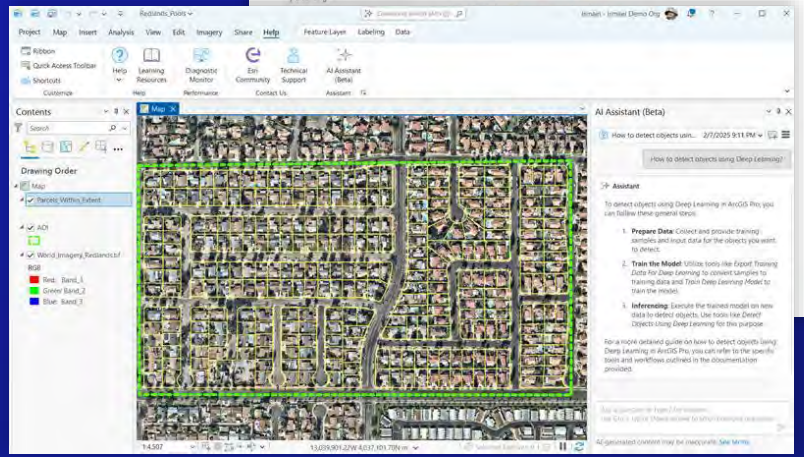
Citizen Query and Engagement

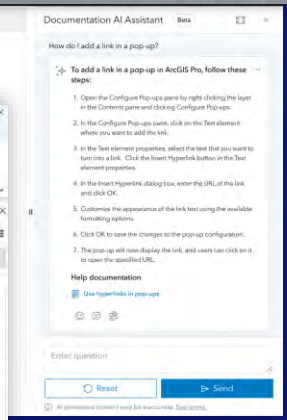








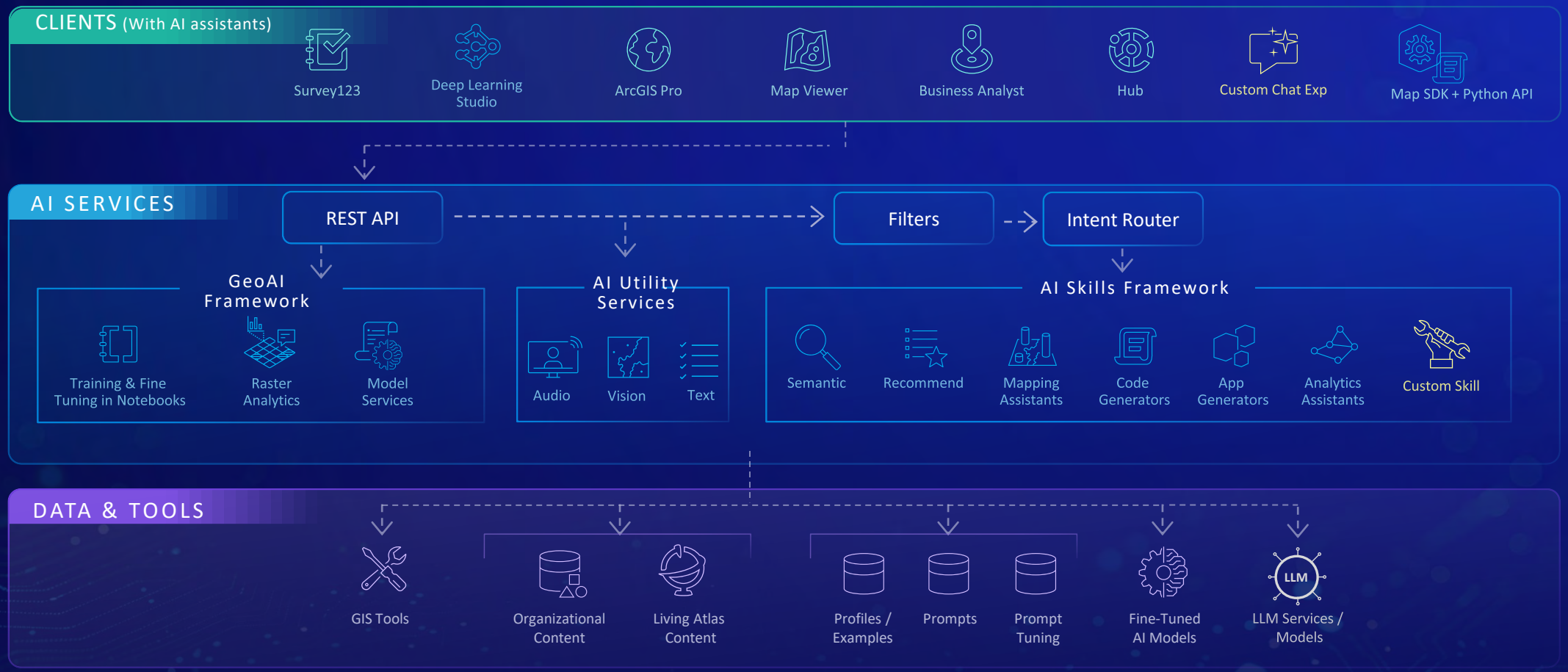




Architecture . . .

ArcGIS is an Open Geospatial AI Platform

A comprehensive architecture for GeoAI, Assistants, Agents and Intelligent Apps



Well architected, Pre-trained GeoAI Models and AI skills as web services, enabling AI within apps and workflows

AI in ArcGIS

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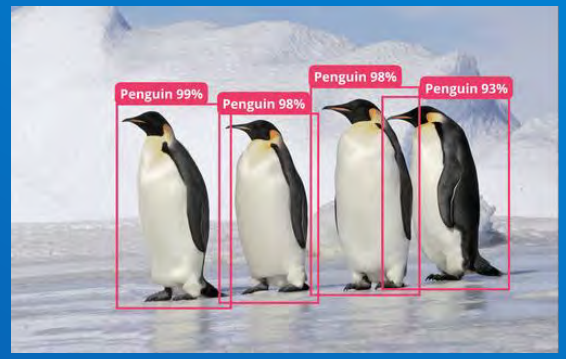
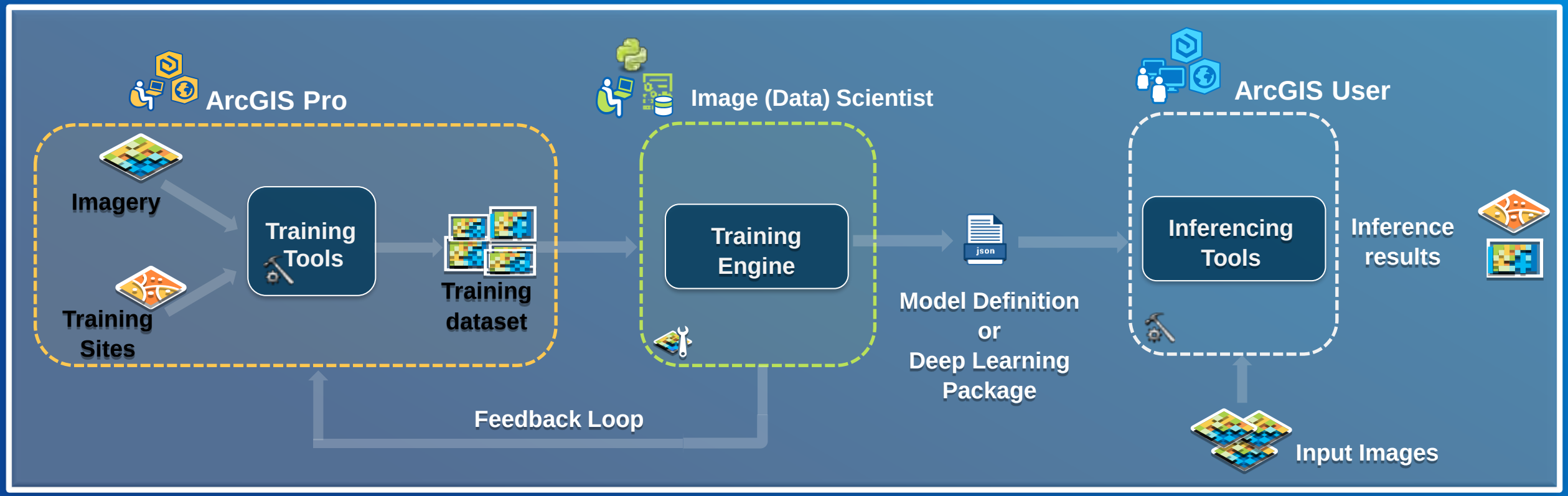
GeoAI in ArcGIS – Deep Learning

- Based on Computer Vision
- Automate repetitive tasks
  - Rule of thumb - Five-year-old within 3 seconds
- Where does GeoAI add value
  - Speed, Efficiency
  - Volume
  - Repeatability
  - Accuracy
- Stochastic versus Deterministic…



GeoAI in ArcGIS – Deep Learning Workflow



GeoAI in ArcGIS – Deep Learning

The are some basic rules to follow when labelling data:

- Label the features you want to extract
  - Also label what you do not want to extract

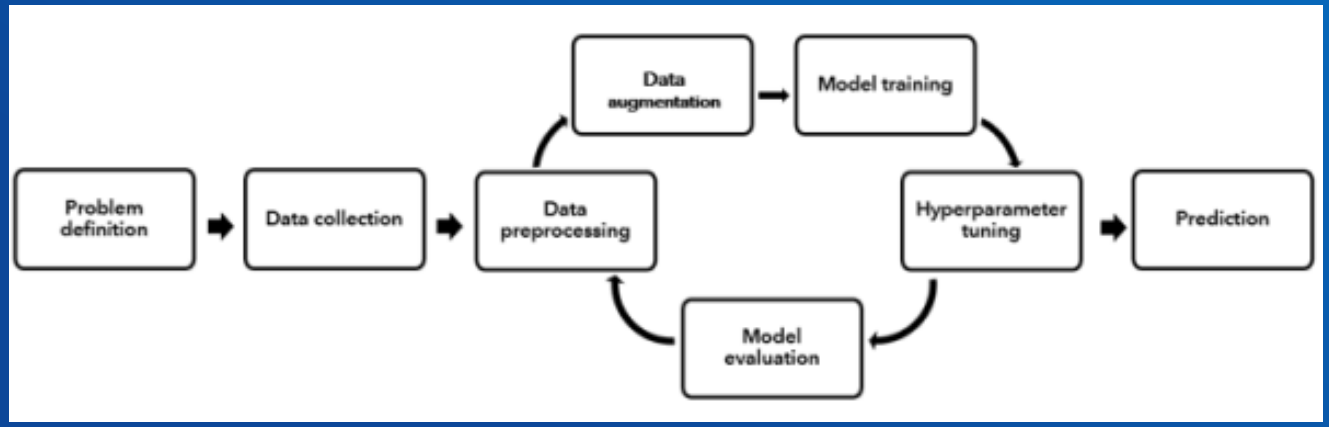
- Label features in context
  - Swimming Pools are traditionally standalone
  - Trees in a compartments need to be labelled together

- Take time to capture a representative sample
  - Capture sufficient training samples
  - Improve sample over time

GeoAI in ArcGIS – Deep Learning

- Multiple Options are Available to build the model
  - Choose the right model
    - SingleShotDetector, RetinaNet, FasterRCNN, YOLOv3, HRNet, ATSS, CARAFE, CascadeRCNN, SAMLora, etc.
    - Understand the differences between the models

  - Consider using AutoDL (This removes the Guesswork)



GeoAI in ArcGIS – Deep Learning

- It takes time….
  - The Training and the Model Building Process takes the most time
  - Rerun the process until you are happy with the results

- Considerations when using Deep Learning models
  - Note Confidence Scores of models
  - Be aware of the Model Accuracies
  - Use appropriate input data

GeoAI models

105 Pretrained & ready to use models

- Cars
- License plate blurring
- Parking lots
- **Land cover**
- Parking spots
- Humans
- Crowd counting
- Face blurring
- **Buildings**
- Roads
- Parcels
- Ag fields
- Swimming pools
- Well pads
- Oil spills
- Palm trees
- Power lines
- **Transmission towers**
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- **Object tracking**

new

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- **Hugging Face Hub integration**
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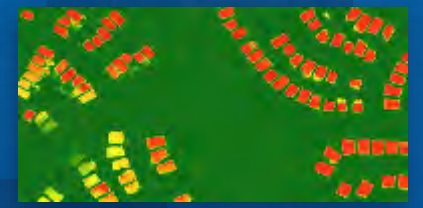
. . . Automating workflows

. . . Creating new data layers



Change detection buildings

Cars (SAM)

Flood segmentation

Clouds

Building footprints

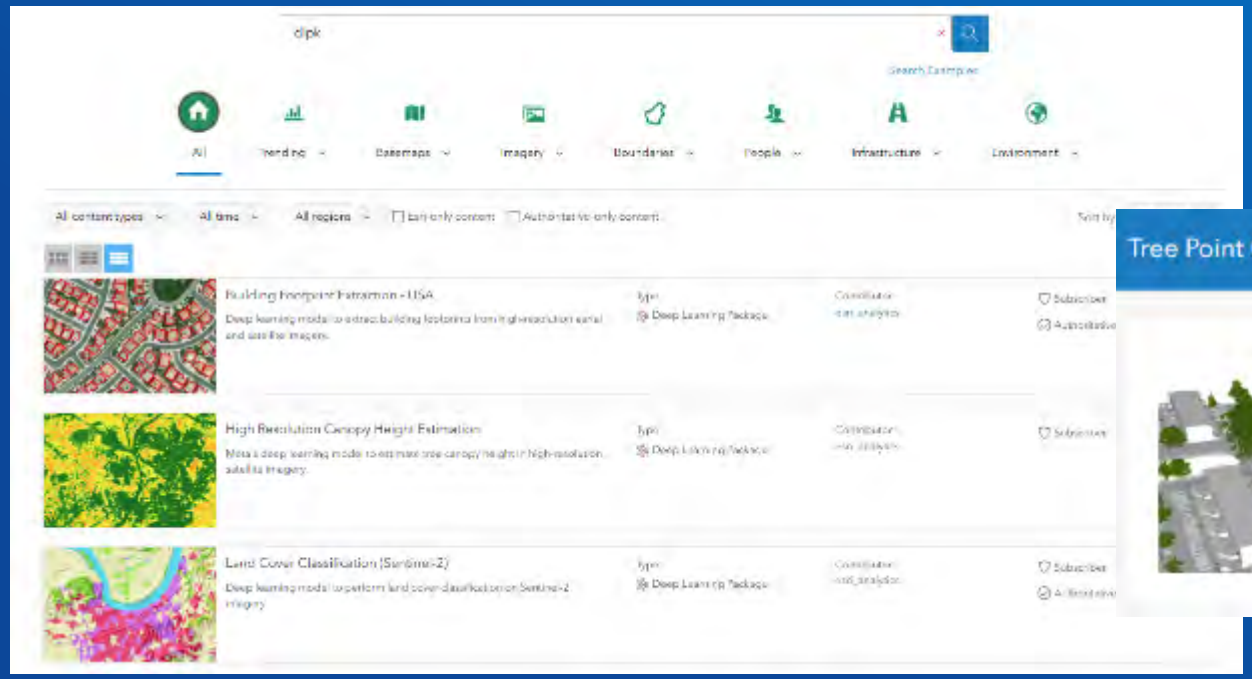
Land cover

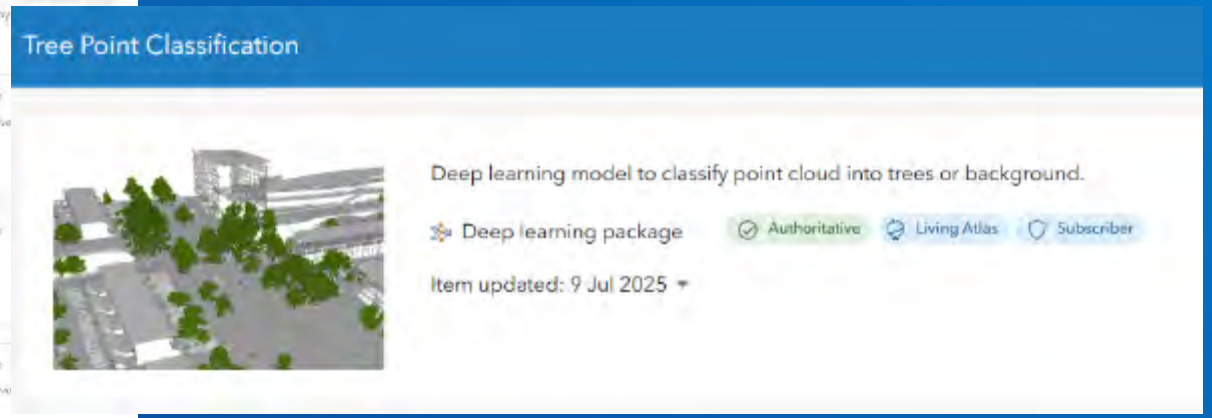
Map simplification

Crop classification (prithvi)

GeoAI in ArcGIS – Deep Learning

- Living Atlas of the World
  - Deep Learning Packages (DLPK)
- The DLPKs can be retrained and improved on local datasets if necessary

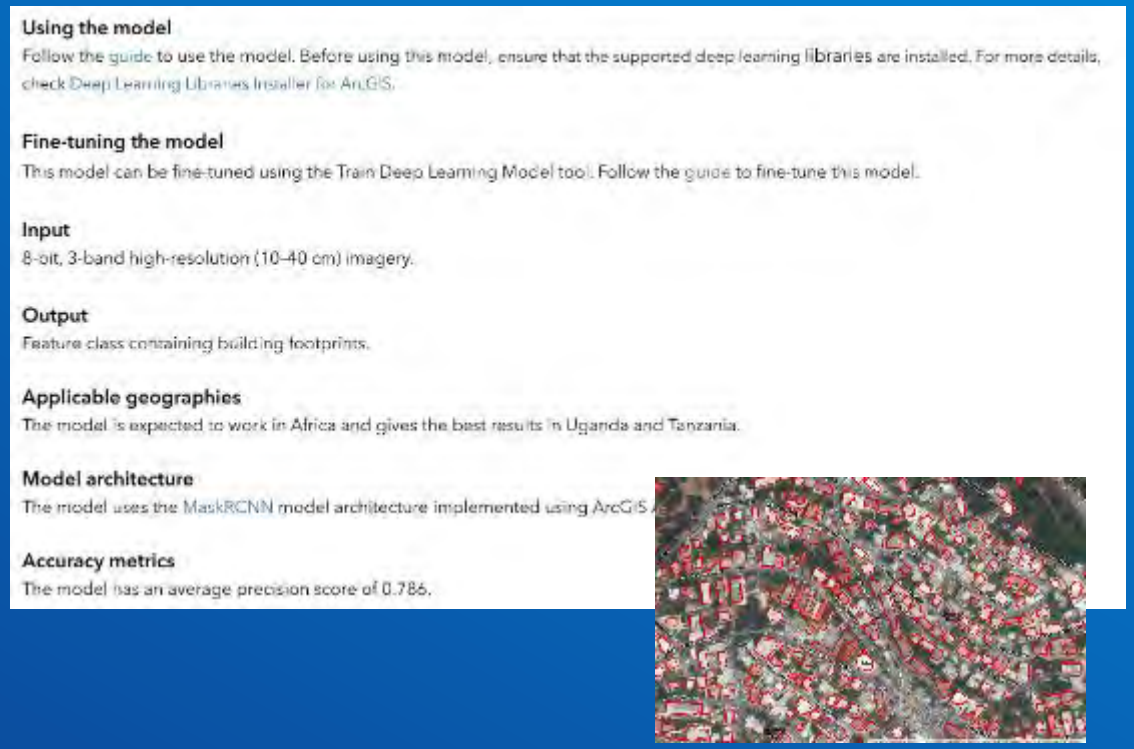




GeoAI in ArcGIS – Deep Learning

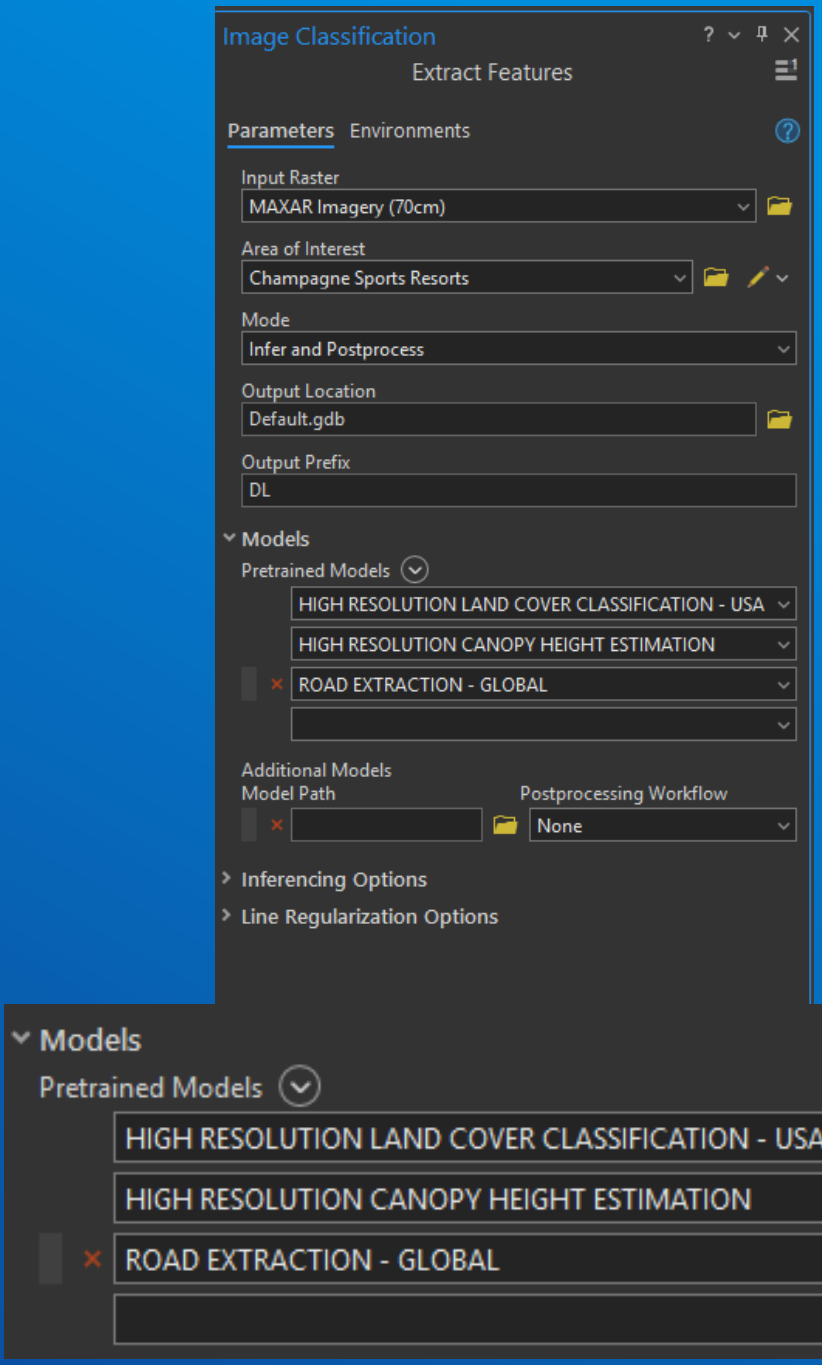
- Types of Models to be demonstrated
  - Object Detection
  - Pixel Classification
  - LAS Point Cloud Classification

- Considerations
  - Input datasets
  - Model Requirements
  - Features to be mapped
  - Computer Requirements
    - GPU



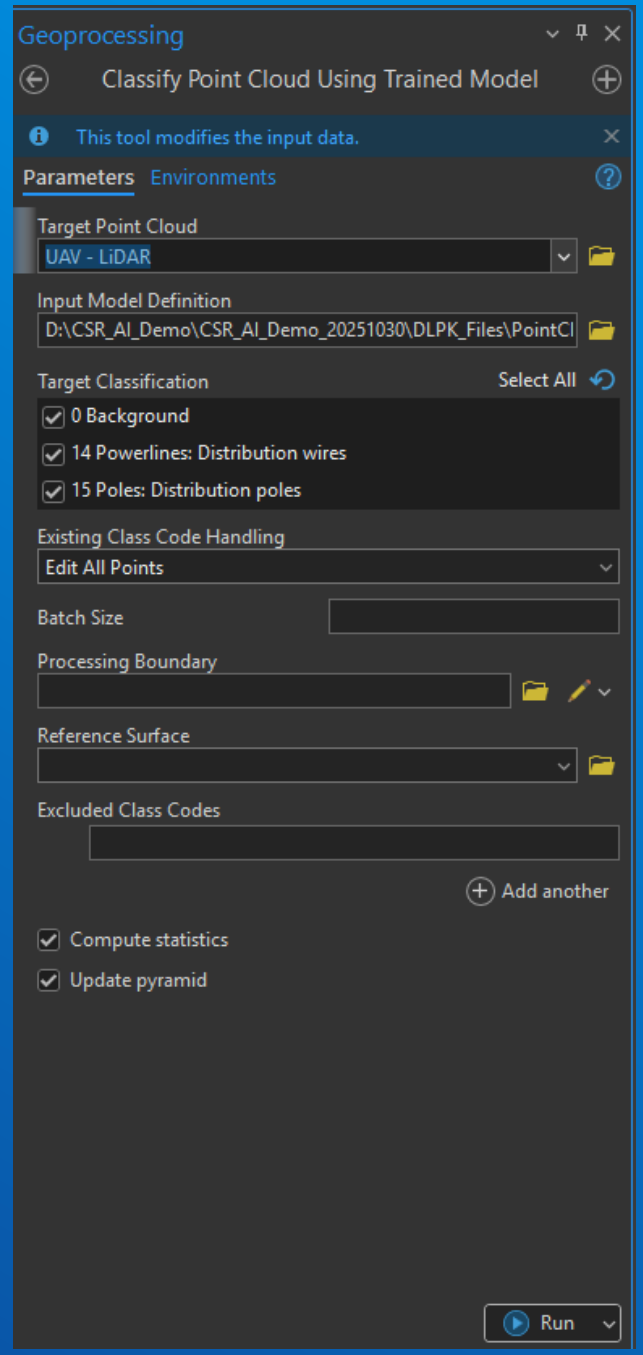
GeoAI in ArcGIS
Object Detection using Deep Learning

- MAXAR 30cm Satellite Imagery (MGP Pro)
  - Resampled to 70cm in line with model requirements
- Considerations
  - RGB Imagery
  - Relevant spatial resolution
  - Define an area of interest
- Outputs
  - HighResolutionCanopyHeightEstimation.dlpk
    - Vegetation Height
  - HighResolutionLandCoverClassification_USA.dlpk
    - Land Cover
  - RoadExtraction_Global.dlpk
    - Roads



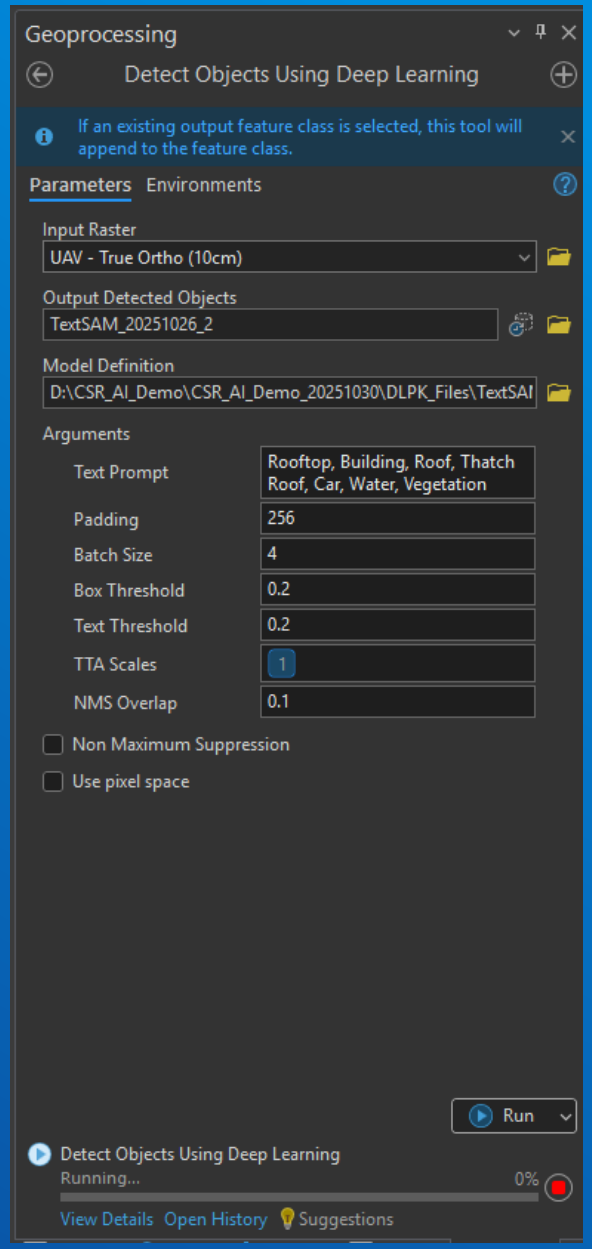
GeoAI in ArcGIS
Classify Point Clouds

- UAV - LiDAR
- Considerations
  - Not a photogrammetric point cloud
    - Must include Return values
  - LAS Dataset
    - Statistics
    - Pyramids
  - Exclude Class codes
- Outputs
  - Tree_point_classification.dlpk
    - Classified Vegetation
  - PointCNN_PowerLines.dlpk
    - Classified Transmission Towers
    - Classified Transmission Lines



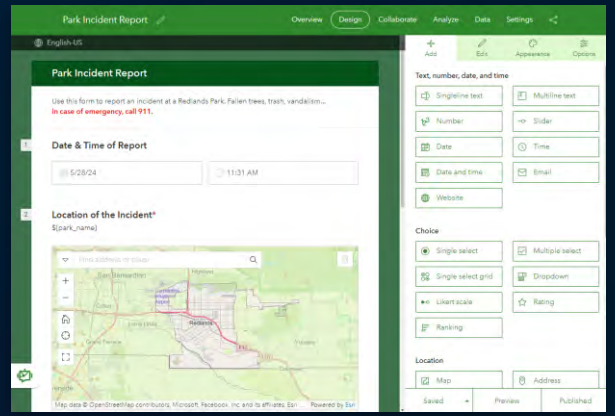
GeoAI in ArcGIS
Object Detection using Deep Learning

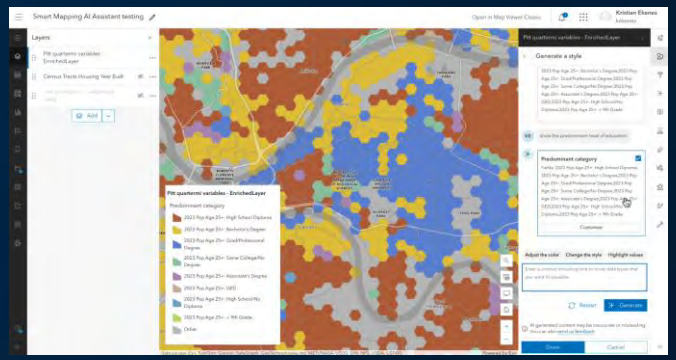
- UAV – True Orthophoto (10cm)
- Considerations
  - Resolution of the input imagery is important
- Outputs
  - TextSAM.dlpk
  - Text Prompt
    - Rooftop, Building, Roof, Thatch Roof
    - Cars
    - Vegetation
    - Swimming Pools, Water

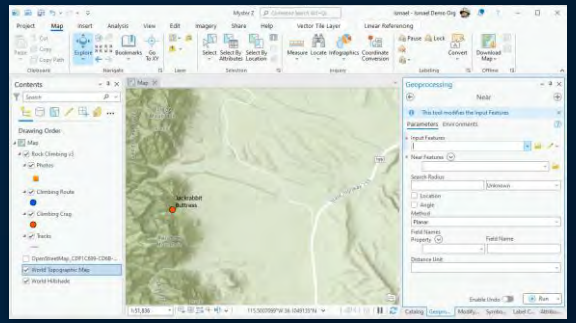


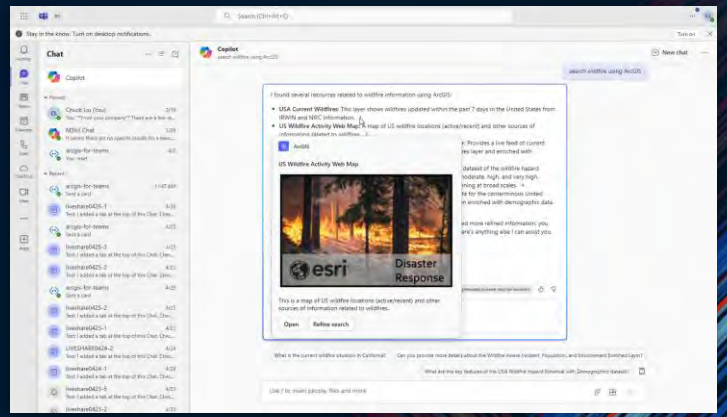
AI Assistants

- Leveraging Generative AI to **streamline** your work
- Allow humans to use **natural language** to have **conversation** with ArcGIS
  - Documentation | All **products**
  - Arcade | Code **generation**
  - Pro | Command **actions**
  - Survey123 | Survey **creation**
  - ArcGIS | Copilot **integration**
  - …



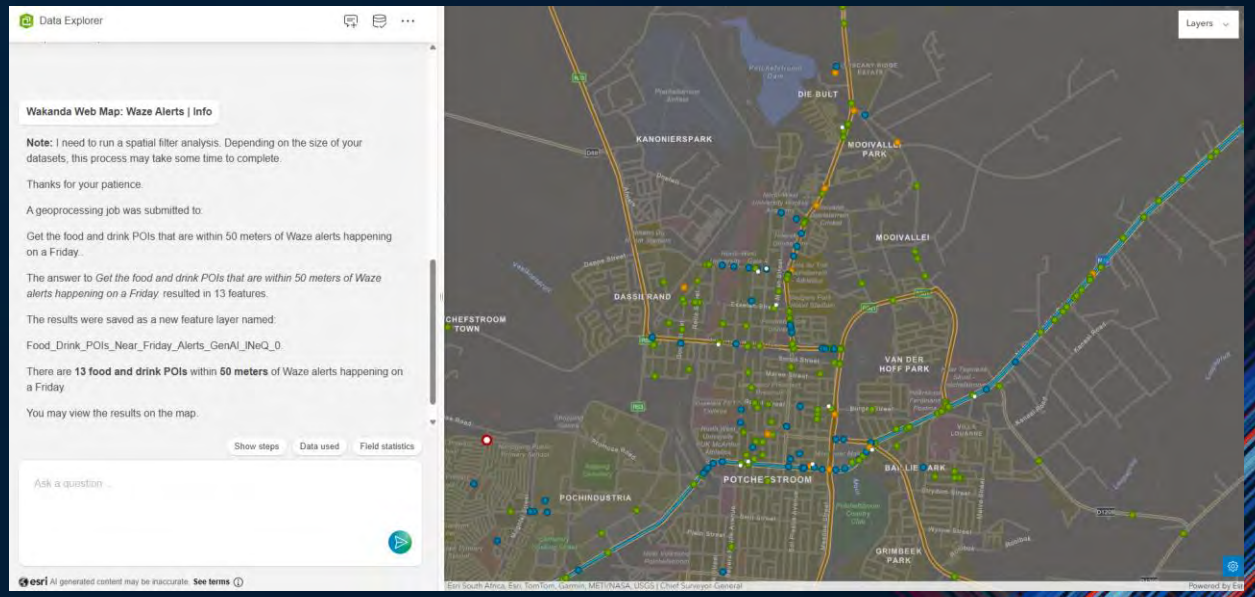






AI Agents

- **Intelligent** orchestrators of AI skills & GIS tools to accomplish **complex** workflows
- Cognitive **backbone** of **modern** AI applications
  - Configurable **Instant App** template
  - Enable **natural language** for:
    - map exploration
    - spatial analysis & filtering
    - data summarization



Foundations of Effective AI Implementation

Trust

Ensuring user confidence in AI systems

Data

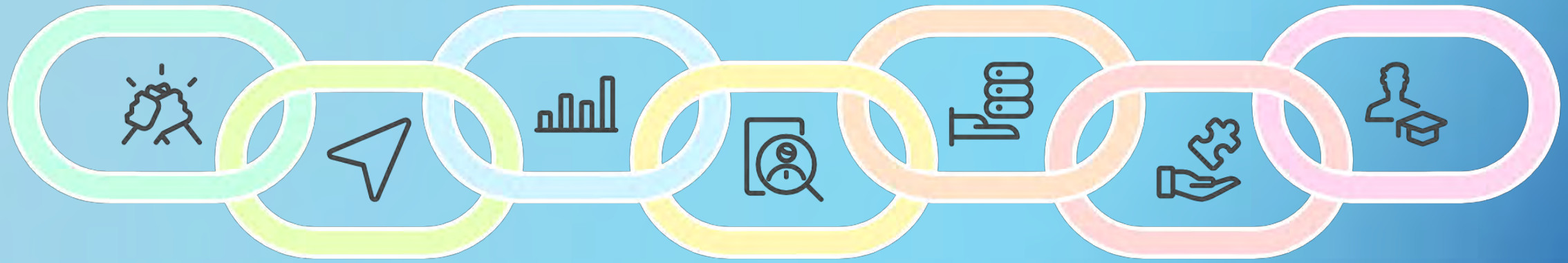
Serving as the backbone for informed decisions

Computation

Impact and cost of running AI

Skills Development

Equipping individuals with necessary expertise



Ethics

Guiding responsible technology use

Validation

Confirming accuracy and reliability of outputs

Fit-for-Purpose

Reading the label, understanding applicability

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