

THE SCIENCE OF WHERE®

GeoAl in ArcGIS - Machine Learning & Neural Networks

Rami Alouta

GeoAl for Humanitarian Relief Agenda & Topics

- GeoAl in the ArcGIS System Overview
- COTs & Foundational Models
- ML & GenAi in the ArcGIS System
- Resources

GeoAl in the ArcGIS System Overview



AI

Analyze



Learn





Analyze

Multi-modal models



LLMs **Read** Prompt Engineering

Learn Lora

Stable Diffusion Create GenAl



GeoAl in ArcGIS Built with Open Science Libraries

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Open python libraries







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Accessible Foundational Models

Automation

Components of Geospatial Al Al overarching

Artificial Intelligence



Feature and Tabular Analysis

Text Analysis





Imagery AI

Time Series AI



Components of Geospatial Al Machine Learning

Artificial Intelligence

- Geospatial machine learning
 - Regression models
 - Tree Mode
 - Decision Trees
- Python Libraries

Machine Learning



AutoML





Components of Geospatial Al Deep Learning

Artificial Intelligence

- Inferencing Workflows:
 - Pixel classification
 - Object detection
 - Object classification
 - Feature extraction
- End to end deep learning workflows

Machine Learning

Deep Learning







Components of Geospatial Al

Large Language Models

- Text Classification
- Address standardization
- Information Extraction

Machine Learning

Artificial Intelligence

Deep Learning

Large Language Models

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Components of Geospatial Al GPTs/Al Assistants

Esri Support Assistant



Map Assistant



Business Analyst Assistant



Artificial Intelligence

Machine Learning

Deep Learning

Large Language Models

GPTs/AI Assistants

ArcGIS Hub Assistant



ArcGIS Survey123



Text Classification

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Artificial Intelligence

Machine Learning

Deep Learning

Large Language Models

GPTs/AI Assistants

- Components of AI
 - Machine Learning
 - Deep Learning
 - Neural Networks
 - Natural Language Processing (NLP)
 - Generative AI
 - Foundation Models (FMs)
 - Large Language Models (LLMs)
 - GPT, Claude, Bard, LLaMa,...

Al in ArcGIS





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

Enhancing the *Experience* of ArcGIS, using intelligent *AI agents* & *assistants*, to understand intent, get insights, perform GIS tasks and generate GIS content.



COTs & Foundational Models



Pretrained GeoAl Models

Available out of the box

- Cars
- License Plate Blurring
- Parking Lots
- Parking Spots
- Humans
 Crowd Counting
- Crowd Counting
- Face Blurring
- Land CoverBuildings
- Building
 Roads
- Parcels
- Ag Fields
- Swimming Pools
- Well Pads
- Oil Spills
- Palm Trees
- Power Lines
- Transmission Towers
- Insulator Defects
 Wind Turbines
- VVind Turbines
- Solar Arrays
- Solar Panels

Ships

- Shipwrecks
 Oil Spille
- Oil SpillsPalm Trees
- Trees
- Plant Leaf Disease
- Common Object Detection
- Text Parsing from Photo
- Object Tracking
- Segment Anything Model (SAM)
- CLIP Zero Shot Classifier
- Text SAM
 Dritbyi (Crop
- Prithvi (Crops, Burn Scars, Floods)
 Building Point Classification
- Wildfire Delineation
- Oil Tanks
- Pylons
- Optical Character Recognition
- Cooling Towers
- Agricultural field boundaries
- Cloud Mask Generation
- Ship Detection
- Tree Segmentation
- Transmission H-Structure Detection

... and Many More



Natural Resources

Insurance

- **Commercial Business**
- National Security

Utilities



121 - D

Elephant Detection

Road Extraction (Global)

Wind Turbine

Detection

Cloud Mask Generation



Solar Park Classification



Land-Cover Classification

Parking Spot Detection

Working with Deep Learning Models in ArcGIS

Foundational Trainable Models

- BDCN_EDGEDETECTOR
- CHANGEDETECTOR
- CONNECTNET
- CYCLEGAN
- DEEPLAB
- DEEPSORT
- DETREG
- FASTERRCNN
- FEATURE_CLASSIFIER
- HED_EDGEDETECTOR
- IMAGECAPTIONER
- MASKRCNN
- MAXDEEPLAB
- MMDETECTION
- MMSEGMENTATION
- MULTITASK_ROADEXTRACTOR
- PIX2PIX
- PIX2PIXHD
- PSETAE
- PSPNET
- RETINANET
- SAMLORA
- SIAMMASK
- SSD
- SUPERRESOLUTION
- UNET
- YOLOV3

DENSENET12	,

- DENSENET161
- DENSENET169
- DENSENET201
- MOBILENET_V2
- RESNET18
- RESNET34
- RESNET50
- RESNET101
- RESNET152
- VGG11
- VGG11_BN
- VGG13
- VGG13_BN

VGG16
VGG16_BN
VGG19
VGG19_BN
DARKNET53
REID_V1
REID_V2
RESNEXT50

WIDE_RESNET50

63%

1k Positives

- SR3
- VIT B
- VIT L
- VIT_H

Deep Learning Workflow

Extracting, detecting and classifying what you see.



Floods - Kenya



Burn Scars – USA

Building Detection - Afghanistan

Damage Detection – Grenada





ML & Gen Ai in the ArcGIS System

GeoAI: Vector & Time Series

AutoML Tools

- Fairness Metrics & Bias Mitigation
- Multi-modal Input (Text And Image as Input for AutoML)



AutoML

Time Series Forecasting

- LSTM & Transformer Models
- Multi-step Forecasting
- Performance Improvements

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Classification



ArcGIS API for Python / API Reference

arcgis.learn module

ArcGIS API for Python

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GeoAl Toolbox

GeoAI: Vector & Time Series

AutoML Tools

- Fairness Metrics & Bias Mitigation
- Multi-modal Input (Text And Image as Input for AutoML)



AutoML

Time Series Forecasting

- LSTM & Transformer Models
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- Performance Improvements

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Classification



ArcGIS API for Python / API Reference

arcgis.learn module

ArcGIS API for Python

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GeoAl Toolbox

Working with GenAl

Using ArcGIS with GenAI

- Work with existing feature services
- Work with attachments
- Describe data
- Extract Information

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else:
<pre>print("analyzing pdf attachment") pdf_chain = PDFExtractChain(model=llm, pdf_path=file_path) result = pdf_chain.extract_from_pdf() attributes = vars(result) attributes["globalid"] = global_id result_df = pd.DataFrame([attributes]) results_pdf = pd.concat([results_pdf, result_df], ignore_index=True) attachment_description = pdf_chain.format_for_attachment(result)</pre>
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Get Map Details

[△] Use generative AI to create descriptions of Web Maps





Summary

ArcGIS has powerful deep learning capabilities

• Support for end-to-end data deep learning workflows

• Pre-trained AI models on the Living Atlas

Desktop / GUI experience for GIS analysts

• Python API / Notebook experience for data scientists



GeoAl Resources

Documentation

Deep learning model architectures

Get an <u>overview of the deep learning model types</u> available in ArcGIS Pro. Learn about their compatible metadata formats and the main use of the specific model types.

Extracting Building Footprints From Drone Data Methods for extracting precise building footprints using drone imagery and deep learning.

Finetuning Pre-trained Building Footprint Model Tailor existing building footprint models to your specific dataset for improved accuracy.

Guides

Install deep learning frameworks for ArcGIS Step-by-step guide to setting up deep learning tools in ArcGIS.

Deep learning using the ArcGIS Image Analyst extension Learn how to apply deep learning to your spatial analysis with ArcGIS.

Deep Learning Using ArcGIS Pro Web Course Comprehensive online course covering deep learning in ArcGIS Pro.





Resources GeoAl Resources