Using Deep Learning Models with ArcGIS to Extract Information From Imagery

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Overview

- ArcGIS and Deep Learning integration for imagery information extraction
- Deep Learning tools in ArcGIS
  - Demo: create training samples
- Deep learning package
  - Demo: write python raster function for deep learning
  - Esri model definition
- Deep Learning Inference in ArcGIS
  - Demo: perform deep learning inference
- Resources
- Q & A
Deep Learning broadly refers to algorithms that break down complex problems using layered algorithm architectures known as “neural networks”, leveraging vast quantities of training data and compute power
Deep Learning: Use Cases

- **Image Classification**
- **Object Detection**
- **Semantic Segmentation**
- **Instance Segmentation**

**Examples:**
- Image Classification: Cat, Dog, Daytime Scene
- Object Detection: Dog, Plane, Airplane
- Semantic Segmentation: Daytime Scene, Map
- Instance Segmentation: Dogs, Planes, Clusters
Deep learning workflow

- Create Training Samples
- Perform Inference
- Train Model
ArcGIS Enterprise and ArcGIS Pro Deep Learning Integration

1. ArcGIS Professional collaborates with Data Scientist and uses the Export Training Data for Deep Learning GP tool in Pro or on the server.
2. Data Scientist uses training data to develop a model.
3. Data Scientist delivers the deep learning model package.
4. ArcGIS Professional receives the model definition packages and configures them for use in ArcGIS.
5. ArcGIS Professional may run inference and publish results.
6. ArcGIS User runs Detect Objects Using Deep Learning GP tool in Pro or on the server.
   - consumes model inference results if ArcGIS Professional prepares them.
6. ArcGIS User runs Classify Pixels Using Deep Learning GP tool in Pro or on the server.
   - consumes model inference results if ArcGIS Professional prepares them.
Deep Learning in ArcGIS Pro

- **Create Training Samples**
  - Training Sample Manager
  - Export Training Data For Deep Learning

- **Perform Inference**
  - Detect Objects Using Deep Learning
  - Classify Pixels Using Deep Learning

- **Post processing**
  - Non Maximum Suppression
Deep Learning in ArcGIS Raster Analytics

**System/RasterAnalysisTools (GPServer)**

**Service Description:** The RasterAnalysisTools service is used by ArcGIS Server to provide distributed raster analysis.

**Tasks:**
- DetectObjectsUsingDeepLearning
- ClassifyPixelsUsingDeepLearning
- ExportTrainingDataforDeepLearning
- QueryDeepLearningModelInfo
- InstallDeepLearningModel
- UninstallDeepLearningModel
- ListDeepLearningModels
Demo

Export Training Data For Deep Learning
Deep learning model package
What’s a *Python* Raster Function?

- Transforming rasters—image processing and analytic algorithms—in Python.

- Implement a raster function from the comfort of your *Python module*.

- Architecture: Module loaded by an adapter—Python-aware *and* a first-class participant in the function chain.

- Your Python module—assisted by ArcGIS—is a raster function.
import numpy as np

class HelloWorld():
    def __init__(self):
        self.name = "Hello World Function"

def getParameterInfo(self):
    return [{
        'name': 'r',
        'dataType': 'raster'
    }]

def updatePixels(self, tlc, shape, props, **pixelBlocks):
    r = pixelBlocks['r_pixels'] + 10
    pixelBlocks['output_pixels'] = r.astype(props['pixelType'])

    return pixelBlocks
The API

- initialize
  - global initialization
- getParameterInfo
  - define all input parameters to the function
- getConfiguration
  - how the input rasters are read
- updateRasterInfo
  - implement if used in classify pixels, define the output raster properties
- getFields
  - implement if used in detect objects, define the fields of the output feature class
- getGeometryType
  - implement if used in detect objects, define the geometry type of the output feature class
The API

- `updatePixels()`

- **Workhorse of the raster function. Process Pixels.**

- **Given:**
  - Expected pixel-block size+location
  - output raster properties (map space)
  - pixels+mask of selected input rasters

- **Returns:** Pixels+mask of requested pixel block.
The API

- vectorize()

- **Workhorse of the raster function. Process Pixels.**

- **Given:**
  - Expected pixel-block.

- **Returns:** String of GeoJSON object.
Demo
# Supported Models and Frameworks

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<th>Detect Objects (Instance Segmentation)</th>
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<td><strong>Other</strong></td>
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</tbody>
</table>

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**out of the box Python Raster Function**

**custom Python Raster Function**

* Image Scientist implements the raster function using Esri provided Python code utilities and samples
Deep learning inference in ArcGIS
Demo

Upload and query deep learning model
Perform deep learning inference
Resources

• ArcGIS/raster-deep-learning repo
  - https://github.com/Esri/raster-deep-learning

• Esri/raster-functions repo
  - https://github.com/Esri/raster-functions

• ArcGIS API for Python
  - https://developers.arcgis.com/python/

• Story Map and Articles
  - https://medium.com/geoai/high-resolution-land-cover-mapping-using-deep-learning-7126fee571dd

• Webinar
  - Integrating Deep Learning with ArcGIS using Python
    https://www.youtube.com/watch?v=osnMPbKJxsE
Download the Esri Events app and find your event

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