Imagery in ArcGIS: What’s New

Peter Becker and Vinay Viswambharan
ArcGIS Provides a Comprehensive Imagery Platform

Seamless integration and analysis of imagery with all spatial data

A scalable platform for working with all forms of imagery (drone, aerial, and satellite) to create valuable information products, integrated with GIS.
Imagery integrated into GIS

Visualization & Exploitation

Management

Analysis

Map Production

ArcGIS
Managing Imagery Accessible

- Working with Imagery in ArcGIS Pro
  - Sensors and format support
- Mosaic Datasets
- ArcGIS Image Server
- Image Services
  - On-The-Fly Processing
  - Dynamic Image Services
  - Persisting Products using Raster Analytics
- Image Management Workflows
- On Premise and Cloud
  - Support for AWS, Azure
  - Many Cloud Storage Options

System of Record
Sensor Support

New or Updated Raster Products & Types

- Sentinel-1 (Radar)
- Worldview-4
- GOES L1B,L2
- Kompasat-3 Level1
- Sentinel-2 Level2
- SkySat
- TeLEOS-1
- ADS40 – LV1

Improved Multidimensional Data Support

- Add data
- Pick variables
- Work with multidimensional raster layers

+ Python Raster Types (GitHub)
Mosaic Dataset
Optimum Data Model for Image Management

- Highly Scalable, from Small to Massive Volumes of Imagery
- Defined in GeoDatabase (File or Enterprise)
- References sources
- Maintains metadata
- Defines processing to be applied
ArcGIS Image Server

- **Dynamic Image Services**
  - Providing Access
  - Dynamic Mosaicking and On-The-Fly Processing

- **Raster Analytics**
  - Persisting Products using Distributed Compute and Storage

- **Ortho Mapping**
  - Creating imagery products from Satellite, Aerial and Drones
Moving to the Cloud

• Simplifying Set up
  - ArcGIS Enterprise + Image Server
  - Cloud Formation, Cloud Builder, CLI
  - Support for AWS & Azure
  - Support for RDS

• Storage Support
  - Optimize Rasters - Supports MRF, TiledTIF, and COG
  - Raster Proxies – Provide optimized caching
  - Cloud Storage Connection Files
    - Direct read from Cloud storage for selected raster types (Landsat, Sentinel, ZY3)
    - Storage support for AWS, Azure, Google Cloud, Aliyun, Huawei
Imagery Workflows
Imagery Best Practices

• Image Management Workflows
  - Preprocessed
  - Elevation
  - HighRes Satellite,
  - ...

Includes: MDCS – Mosaic Datasets Configuration Scripts
Automation of Image Service Creation
Imagery Content Projects

- Sentinel 2
- World Elevation
- Landsat
- NAIP

Partners
- DigitalGlobe, Deimos Imaging, Vexcel, NearMap, ClarkLabs,…
Creating precise imagery derived products

Satellite, Aerial, Drones

Orthophoto production
  Block Adjustment
  Digital Elevation Model Generation

Drone2Map, Ortho Mapping, Ortho Maker
  OrthoMosaics, DTM, DSM
  Tile Cache Generation
  Dynamic Image Services

Stereo Display and Feature Extraction
  Satellite, Frame Camera, ADS

System of Record
Ortho Mapping

Drone2Map
Stand Alone App for Windows

ArcGIS Pro
Ortho Mapping Workflow

Ortho Maker
WebApp on ArcGIS Image Server
Drone2Map in ArcGIS

*Generate 2D and 3D Products from Drone Imagery*

- Orthorectified mosaics
- Terrain models
- Point clouds
- 3D meshes

- Process in the field or in the office (laptop)
- Batch processing of multiple collects
- Share flight data and derivative products to ArcGIS Online or ArcGIS Enterprise

Version 1.3.1

- Better multispectral camera support
- Point cloud improvements
- Automated point cloud classification
- Improved DTM generation
- OSGB mesh output (in addition to I3S)
- Processing speed improvements
Demo
Drone2Map
Ortho Mapping

Ortho mosaics & DEMs from Satellite, Aerial & Drone Imagery
Rapid streamlined processing

ArcGIS Pro Advanced
ArcGIS Pro Advanced + ArcGIS Image Server
App + ArcGIS Image Server
Demo
Ortho Mapping
Ortho Maker

Web based user interface for uploading and processing Ortho Mapping workflows on Drone Imagery

*Ortho Maker is not a product sold separately, it is a capability of ArcGIS Enterprise + ArcGIS Image Server*
Demo
Ortho Maker
Extracting Information from Imagery

ArcGIS Pro Image Analyst Extension

Machine Learning, Prediction, Classification, Deep Learning

Tools built into ArcGIS

Integration with External Toolkits

Scaling using Raster Analytics
ArcGIS Pro Image Analyst Extension
All-in-one Imagery Analysis Workstation at your fingertips

• **ArcGIS Pro 2.1**
  - Stereo Display and Capture
  - Image Space Display, Capture, and Mensuration
  - Advanced Image Analysis

• **ArcGIS Pro 2.2**
  - Full Motion Video (FMV)
Raster Functions
Processing imagery in ArcGIS

• Primary information model component which processes raster data
• Takes input pixels and transform output pixels into meaningful products

• Raster functions to process:
  - Pixels/block of pixels
  - Raster datasets or a collection of raster datasets
  - Mosaic datasets

• Geometric or Radiometric
• 100+ out-of-the-box
• Chained together to create “processing chains”

• Extensible https://github.com/Esri/raster-functions
## Raster Functions

### ArcGIS Pro

<table>
<thead>
<tr>
<th>Multiband Math</th>
<th>~50 Raster Functions</th>
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<tbody>
<tr>
<td>Arithmetic</td>
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<tr>
<td>Band Arithmetic</td>
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<thead>
<tr>
<th>Analysis: Band Math &amp; Indices</th>
<th>NDVI / NDVI Colorized SAVI / MSAVI / TASI GVI GVI (Landsat TM) PVI Tasseled Cap (Kauth-Thomas) Binary Thresholding Heat Index Wind Chill</th>
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<th>Statistics</th>
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<tr>
<th>Visualization &amp; Appearance</th>
<th>Contrast and Brightness Convolution Pansharpening Resample Statistics and Histogram Stretch</th>
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### Image Analyst

<table>
<thead>
<tr>
<th>Interpolation</th>
<th>~60 Raster Functions</th>
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<tbody>
<tr>
<td>Interpolate Irregular Data</td>
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<td>- Nearest Neighbor</td>
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<td>- IDW</td>
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<td>- EBK</td>
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### Surface Generation & Analysis

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<thead>
<tr>
<th>Data Management &amp; Conversion</th>
<th>Raster to Vector Vector to Raster Colormap Colormap To RGB Complex Grayscale Remap / Reclass Spectral Conversion Unit Conversion Vector Field LAS to Raster LAS Dataset to Raster Clip Composite Extract Bands Mask Mosaic Rasters Rasterize Features Reproject</th>
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<th>Python</th>
<th>Custom Algorithms</th>
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<tr>
<th>Analysis: Image Segmentation &amp; Classification</th>
<th>Segmentation (Mean Shift) Training (ISO, SVM, ML, Random trees) Supervised Classification</th>
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<tr>
<th>Analysis: Overlay</th>
<th>Weighted Sum</th>
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<th>Statistics:</th>
<th>Zonal Statistics Cell Statistics</th>
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<tr>
<th>Math</th>
<th>Round Down Round Up Square Con TanH Greater Than Equal</th>
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<tr>
<td>Calculator</td>
<td>Square Root Set Null Bitwise Less Than Not Equal</td>
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<td>Abs</td>
<td>Times And Left Shift Not Less Than Equal</td>
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<td>Exp10</td>
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<td>Exp2</td>
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### Spatial Analyst

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<tr>
<th>Spatial Analyst</th>
<th>~13 Raster Functions</th>
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<tr>
<th>Analysis: Distance &amp; Density</th>
<th>Euclidean Distance Cost Distance Least Cost Path Kernel Density</th>
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<tr>
<th>Analysis: Hydrology</th>
<th>Fill Flow Accumulation Flow Direction Flow Distance Stream Link Watershed</th>
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<tr>
<th>Data Management</th>
<th>Nibble</th>
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Demo – Raster Functions

Terrain Ruggedness Index
- Client side
- Server Side
Image Classification and Deep Learning

Improvements

• Distributed image classification and segmentation
  - No change to the existing workflow
  - Inputs and outputs are web image layers
  - Create persisted products - accessible via Enterprise portal

• Deep learning
  - ‘Export training data for deep learning’ GP tool

ArcGIS Pro 2.2 – Image Analyst extension
Deep Learning in ArcGIS

Built-in Tools within ArcGIS

- Maximum Likelihood Classification
- Random Trees
- Support Vector Machine

Integration with External Toolkits

- Access Training Data
- Consuming Model Outputs
- APIs to build solutions
Enterprise Raster Analytics Hydro Tools

- Distributed as of 10.6
  - Fill
  - Flow Distance
  - Flow Direction
  - Flow Accumulation
  - Watershed
  - Stream Link
  - Nibble

Mississippi (HUC2 Regions 7-12 @ 10m) ~105 billion cells

- Fill: 18h 39m 23s
- Flow Accumulation: 23h 40m 24s
- Flow Direction D8: 4h 46m 22s
- Flow Direction D∞: 13h 5m 21s

4 in-house commodity servers (desktops) running 8 RA processors each

To date these workflows with such large volumes of data require supercomputing technologies
Raster Analytic User Experience

Pro

Web

Python API
Demo – Raster Analytics Clients

ArcGIS Pro as a Client
Web map Viewer as a client
R-ArcGIS Bridge

- Connect ArcGIS to R
- Seamless transfer of data back and forth
- Integrate R and ArcGIS functionality

- Read and write raster data
  - Read large image in chunks by band
  - Compatibility with Mosaic Datasets
  - Create subsets by bands or pixel rows and columns
  - Define resample
  - Select desired pixel format for different analyses
ArcGIS Pro Spatial Analyst - New Raster Functions

**Pro 2.1**

- Hydrology functions:
  - Fill
  - Flow accumulation
  - Flow direction
  - Flow distance
  - Stream link
  - Watershed

- Analysis function:
  - Nibble

- **Scalable using enterprise**

**Pro 2.2**

- Aspect Slope (Basic)
- Additional Spectral Indices (Basic)
- Cost path link
- Cost back link
- Euclidean direction
VISUALIZATION & EXPLOITATION

*Integrating imagery into dynamic applications to aid understanding*

**Desktop**
- ArcGIS Pro + Image Analyst Extension
  - Image Space, Mensuration
  - Stereo
  - Motion Video

**Web**
- Map Viewer enhancements
- Image Configuration Apps
- WABIS
  - Engaging Visualization Tools
  - Interpretation tools

**Mobile**
- Focused Apps
- LT Mosaic Dataset in RunTime

*System of Engagement*
Visualization and Charting Tools in ArcGIS Pro

Exploit and interpret patterns in imagery

• Image Selector
  - Easy UX for finding/selecting an image or set of images
  - Treats a mosaic dataset/Image service like an image Library

• Temporal Profile
  - For time-series based imagery
  - Monitor features or areas of interest over time spectrally
  - Designed to explore multidimensional raster data.
  - Supports multiple variables, multiple bands of a variable and multiple dimensions of a variable

• Spectral Profile
  - Plots the spectrum of all bands for a selected pixel.
  - Given the band wavelengths, spectral reflectance from any multispectral dataset can be charted.
  - Easily separate features or areas of interest

• Scatter Plot
  - Used to examine the association between image bands and their relationship to features and materials of interest
  - Used to identify anomalies and outliers
Demo
Image Selector & Charting tools
Web Maps and Apps

• JavaScript API 4.0 Improved:
  - Client side renderer
  - Image Coordinate System Support

• Map Viewer
  - Image Filter
Configurable Imagery Apps

- Focused apps to work with imagery
- Common Tasks
- No programming required
- Make collections of imagery easily accessible
- Query, visualize, and interpret imagery layers through time and space

**WABIS** – Web App Builder for Image Services
Library of Open Source Widgets
https://github.com/Esri/WAB-Image-Services-Widgets
Extending Imagery Modalities

Mosaic Dataset
Extending Imagery Modalities

Mosaic Dataset

Oriented Imagery
Oriented Imagery

Access imagery at any angle, for any location

Pro Add In
Web App Widget
Management and Publishing Tools
Integration with many Content Providers
Available from the Marketplace, free

Early Adopter Release - UC 2018
Please Take Our Survey on the App

Download the Esri Events app and find your event

Select the session you attended

Select the Feedback tab

Complete answers and select “Submit”