Raster Analysis and Image Processing in ArcGIS Enterprise

Vinay Viswambharan, Jie Zhang
Overview

Patterns of use
- Introduction to image processing and analysis in ArcGIS
- Client/Server side processing
- Desktop vs. enterprise processing
- Image processing in ArcGIS Pro and the web map viewer

Patterns of implementation
- Raster Analytics configuration
- Raster Analytics system components
- Raster Analytics deployment
- Types of Raster Analytics operations
- Raster Analytics and the REST API
- Best practices
The ArcGIS Platform
Is a comprehensive Imagery Platform

Derive actionable information from imagery

System of Insight
Creating the applications that enable imagery to be accessible to all that need it in the suitable applications.

System of Record
manage and process imagery into authoritative data

Content from all sources

Professional Imagery & Geospatial Analysts

Enterprise

ArcGIS GIS Server
ArcGIS GeoEvent Server
ArcGIS Image Server
ArcGIS GeoAnalytics Server
ArcGIS Business Analyst Server

System of Engagement
• Process images to create new images (traditional image processing)
• Process images on-the-fly to create dynamic virtual products
• Process images to create tiled image maps
  - Georeferencing and Orthorectification
  - Color Balancing
  - Seam line generation
  - Caching to tiles
• Geoprocessing tools
  - More than 80 tools for image management and processing
• Raster Functions
  - Can be applied to Raster Datasets, Mosaic Datasets, and Image Services
System Of Insight
Image processing and analysis in ArcGIS

- Client side processing
- Pixels are processed locally
- Processing is done On-the-fly
- Used to visualize or preview analysis
- Server side processing
- Pixels are processed on the server
- Processing is done On-the-fly
- Primarily used to visualize or preview analysis
- 2 modes:
  - Processing defined by web service author
  - Processing transmitted by the client to the server for execution
System Of Insight
Image processing and analysis in ArcGIS

- Client side
- Server side
- Enterprise

- Run by an individual
- Run on the server
- Distributed processing of large jobs on the server
- Results are persisted
Enterprise Image Server with Distributed Raster Analysis

- From 10.5, ArcGIS has a new way to create and execute spatial analysis models and image processing chains which leverage distributed storage and analytics
  - Raster Analysis works with your existing GIS data and imagery
    - register your data with Image Server without converting
  - Raster Analysis can optimize your data for distributed analytics
    - result imagery is written into distributed raster storage for improved scalability
  - Raster Analysis is designed to scale with your organization’s demands
    - scale up to get the job done quicker, scale down when resources are not needed
Enterprise Image Server with Distributed Raster Analysis

- Complete analysis task for data too big for single desktop machine
  - Meet time constraint (Month -> Weeks -> Days -> Hours -> Minutes)

Dynamic Raster Models

Geoprocessing Models

Server-based Distributed Raster Analytics with Distributed Raster Data Storage

(persistent) distributed analytics with optional distributed storage for even greater scalability

Web GIS Layers

on-the-fly processing

powerful analytics

rich geoinformation model
Raster Analysis Capabilities

Large Collection of Raster Functions

**Multiband Math**

**Arithmetic**
- Calculator
- Abs
- Divide
- Exp
- Exp10
- Exp2
- Float
- Int
- Ln, Log10
- Log2
- Minus
- Mod
- Negate
- Plus
- Power
- Round Down
- Round Up
- Square
- Square Root
- Times

**Band Arithmetic**
- ACos
- ACosh
- ASin
- ASinh
- ATan
- ATanh
- Cos
- Cosh
- Sin
- Sinh
- Tan
- Tanh
- Con
- Set Null

**Correction**
- Apparent Reflectance
- Geometric Correction
- Speckle Filtering (Lee, Frost, Kuan)
- Thermal noise *
- Radiometric Calibration *

**Data Management & Conversion**
- Raster to Vector
- Vector to Raster
- Color Map
- Color Map 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
- Nibble **

**Interpolation**
- Interpolate Irregular Data
  - Nearest Neighbor
  - IDW
  - EBK
- Swath

**Visualization & Appearance**
- Contrast and Brightness
- Geometric Correction
- Pan sharpening
- Resample
- Statistics and Histogram
- Stretch

**Surface Generation & Analysis**
- Aspect
- Curvature
- Elevation Void Fill
- Hillshade
- Shaded Relief
- Slope
- Viewshed *

**Analysis: Image Segmentation & Classification **
- Segmentation (Mean Shift)
- Training (ISO, SVM, ML)
- Supervised Classification

**Analysis: Distance & Density** *
- Euclidean Distance
- Cost Distance
- Least Cost Path
- Kernel Density

**Analysis: Overlay**
- Weighted Overlay *
- Weighted Sum **

**Analysis: Band Math & Indices**
- NDVI / NDVI Colorized
- SAVI / MSAVI / TSAVI
- GEMI
- GVI (Landsat TM)
- PVI
- Tasseled Cap (Kauth-Thomas)
- Binary Thresholding

**Analysis: Hydrology** **
- Fill
- Flow Accumulation
- Flow Direction
- Flow Distance
- Stream Link
- Watershed

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Chain functions together into Raster Models and apply them to answer complex questions
Image Processing and Analysis Demo

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Raster Analysis
System Deployment
Raster Analytics System Configuration

Hosting server

ArcGIS Server

Image Server

Distributed Raster Data Store

Image hosting server

Portal

ArcGIS Pro

Web map viewer

ArcGIS Services

Files

Gdb

Imagery and GIS Data
Deployment platform

- **On-premise + network file shared storage appliance**
- **Cloud platform + Cloud Object Storage**
  - ArcGIS Cloud Builder for Azure
  - Amazon Cloud Formation template or Command line tool

Raster Store

- **New ArcGIS server data store type**
- Raster Store registered to Image Server is for storing output imagery of Raster Analysis tasks
  - Shared file system storage
  - Cloud Object Storage
    - Amazon S3
    - Azure Blob Storage

  **Note:** register a Cloud Store first then register a Raster Store reference to the Cloud Store
- Feature output of Distributed Raster Analysis stored in Hosting server’s
Optimized Cloud Raster Format (CRF)

- **New ArcGIS Raster Dataset format for distributed read/write**
  - Default output imagery format for Raster Analysis tasks
  - Image is split to “bundles” with optimized schema
  - Support cloud storage and file system
  - Published as “hosted” image service
  - Rendered through Raster Rendering service
Distributed Raster Analysis System Services

Geo Processing service as master

Image Service as worker

Image Service for rendering output
Generate Raster tool is the generic service tool takes raster function as input to support various analytic workflows.
Raster Analysis REST API

- **Service tool create hosted image service before generating result image**
- **Use Raster Function JSON object to define your analysis and processing workflow in Generate Raster tool**
  
  [http://esriurl.com/rasterfunc](http://esriurl.com/rasterfunc)
- **More REST API reference**
  
  [http://esriurl.com/rarestapi](http://esriurl.com/rarestapi)
Custom Python Raster Function Deployment

- Custom Python Raster Function has to be deployed by Enterprise administrator to each server install for it to be used in Raster Analysis.
Types of Distributed Raster Analysis Operations

- Different type of operation poses different challenge to parallelization
- Distributed Raster Analysis supports
  - Local/Focal analysis
    - Most raster functions
    - Custom python raster functions
  - Zonal analysis
    - Zonal statistics
  - Global analysis
    - Hydrology Analysis
    - Cost Distance

ref: [http://esriurl.com/typeofops](http://esriurl.com/typeofops)
Case Study: Hydro workflow scalability

- Computing hydrologic characteristics and flow patterns for US
  - For predicting stream flow and flood forecasting
- Old single thread tools required manual chunking of input
  - Performance suffered over half billion cells
- Now running 500x larger data on a distributed cluster

30m US - 25 Billion cells
57 separate processing units

10m US - 230 Billion cells
Desktop App to Utilize Enterprise Raster Analysis

- Instead of using local process (ArcSOCP), Desktop app can utilize server-side Distributed Raster Analysis

- Note:
  - Input data has to be shared with server account
  - Result will be shared as hosted image service
  - Server account must have write privilege to output location
  - Output location may not be registered as raster store
  - Does not support cloud storage
Enterprise Raster Analysis Clients

- ArcGIS Pro/Desktop
- Portal Webmap
- ArcGIS API for Python
Best practice, tips and tricks

- Split Raster Analytic and Image Hosting roles
- Increase server maximum heap memory for processing very large image
- Adjust maximum number of processing service instances based on machine specs
- A single raster analysis task is always default to use up to 80% of all the available raster processing service processes