Imagery and Raster Data in ArcGIS
An Introduction

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Introduction
Imagery in ArcGIS

• **Opening Remarks**

• **Who should be here?**
  - New to ArcGIS
  - Users interested in ArcGIS’ imagery capabilities
  - Users struggling with your use of imagery
  - Users struggling with Esri terminology
  - Users with questions about what imagery is available
  - Users that have used imagery in one way and want to use it in new ways
General Outline
Imagery in ArcGIS

• Why use imagery in a GIS?
• Sources of imagery
• ArcGIS Imagery Information Model
• What can I do with imagery in ArcGIS?
Why use imagery in GIS?
Imagery

If I see it, I can understand it...

...Understanding our world
A friend asked me to check out his farm…
A friend asked me to check out his farm…
A friend asked me to check out his farm...
Imagery Characteristics - Timely
Imagery Characteristics - Metric
Sources of Imagery
Imagery Base Maps

Sources of Imagery

- **Most often used as a “only a backdrop”**
  - georeferenced picture for visualization
  - cached imagery (lossful in many ways)

- **Typically stored in a data structure…**
  - which is extremely efficient for visualization (tiles)
  - which works well on all devices and platforms

- **Often free “to the user”**

- **Timeliness can be an issue**

- **Limited analytical capabilities**
# ArcGIS Imagery Base Maps

## Sources of Imagery

<table>
<thead>
<tr>
<th>Base map</th>
<th>Source</th>
<th>GSD</th>
<th>Features</th>
<th>Timeliness</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGOL World Imagery</td>
<td>Varied</td>
<td>Typical 1m – 0.15m</td>
<td>Manmade</td>
<td>1-3 year</td>
</tr>
</tbody>
</table>

![Map selection interface](image)
Analytical Sources
Sources of Imagery

• Primarily used to acquire feature data
• Typically derived from Remote Sensing devices
  • Satellite, Aerial, RADAR,…
• Typically stored in a data structure…
  • which is designed for full analytical capabilities
  • which is rich with metadata
• Vary in cost and are rarely free
  • Modality vs. Timeliness vs. GSD vs. Product Level
• Analytical in nature
  • interpretation and exploitation, classification, change detection, feature extraction
## ArcGIS Analytical Imagery
### Sources of Imagery

<table>
<thead>
<tr>
<th>Image Service</th>
<th>Source</th>
<th>GSD</th>
<th>Features</th>
<th>Timeliness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landsat GLS</td>
<td>Landsat GLS</td>
<td>15m pansharpened</td>
<td>Natural</td>
<td>Historic epic</td>
</tr>
<tr>
<td>Landsat 8</td>
<td>Landsat 8</td>
<td>15m pansharpened</td>
<td>Natural</td>
<td>Most recent</td>
</tr>
<tr>
<td>NAIP (US only)</td>
<td>4 bands</td>
<td>1m</td>
<td>Manmade/natural</td>
<td>Current year</td>
</tr>
</tbody>
</table>
ArcGIS integrates all types, sources, and sensor models

Sources of Imagery

- Multi-Spectral
- Panchromatic
- Full Motion Video (FMV)
- Thermal
- LiDAR
- RADAR
- Aerial
- Satellite

...Imagery is a Fundamental Part of the Systems
ArcGIS includes many tools for Visualization, Analysis, and Data Management of imagery.

Sources of Imagery

- Color Balance
- Mosaicking
- Ortho-Rectification
- Classification
- Change Analysis
- Pan Sharpen
- 3D Measurement
- Automatic Alignment

Open and Leveraged by Partners
Underlying Design Principles

ArcGIS Imagery Information Model

• **Only process what you need, …when you need it**
  - Operate on the original source imagery – no preprocessing
  - Request-Based processing

• **Intelligent use of the metadata**
  - Virtual Products (e.g. NDVI on-the-fly)
  - Mensuration

• **Optimize storage requirements**
  - reference the imagery files - don’t move or make copies
  - derive many products from a single source and storage

• **Manage massive collections of imagery and make them easily accessible**
  - manage imagery in the enterprise (Mosaic Datasets)
  - web-enable imagery (Image Services, ArcGIS Online, Portal for ArcGIS, caching tools, …)
Architectural Principles
ArcGIS Imagery Information Model

- An ArcGIS Information Model is…
  - A data model + business logic
  - Stored in a Geodatabase (File, Enterprise, …)
  - Cross product (desktop, server, mobile, web, …)
  - Rich and robust
  - Accessible via Public APIs
Model Components
ArcGIS Imagery Information Model

- 6 Key Components
  - Raster Dataset
  - Raster Type
  - Raster Function
  - Raster Product
  - Mosaic Dataset
  - Image Service

- component names == terminology
  - “You web enable your imagery by publishing your Mosaic Dataset as an Image Service.”
The Raster Dataset is the primary information model component which represents a basic image with basic behavior.

Its role is to read and write image storage (pixels) and metadata.

Comprehensive Support
- 1 or N Bands
- 1-64 bits per band
- compressed or uncompressed
- > 80 formats supported
- pyramids (rrd, ovr, internal...)

Read image files directly – no need to convert

"It’s what you get if you drag a GeoTIFF into ArcMap."
Demo
Raster Dataset
The Raster Type is the primary information model component which represents the intelligent business logic for a particular sensor or image product coming from a vendor.

It’s role is too…
- Define pixel storage and metadata schema
- Define the rules for ingesting imagery into ArcGIS
- Define the default processing chains
- Define the georeferencing (sensor model + parameters)

Sensor and/or Format Specification specific

40+ Raster Types
- Applanix
- CDRG
- ECRG
- CIB
- DMCii
- DTED
- Formosat-2
- GeoEye-1
- HRE
- IKONOS
- ISAT
- Kompas-2
- Landsat 1-5
- MSS
- Landsat 7
- TM
- ETM+
- Landsat 8
- LAS
- NITF
- Pleiades-1
- Quickbird
- RapidEye
- Radarsat 2
- SOCET (SUP)
- SPOT 5
- SPOT 6
- WorldView-1
- WorldView-2
- WorldView-3
Demo
Raster Type
The Raster Function is the primary information model component which processes image data.

It’s role is to take input pixels and produce altered output pixels.

A Raster Function
- processes a single pixel or block of pixels (not the full image)
- can make geometric modifications to the pixels (orthorectify, project, clip,…)
- can make radiometric modifications to the pixels (band math, convolution filters, Tasseled Cap,…)

Raster Functions are chained together to create simple or advanced processing chains
- pixels that flow through the chain are virtual in nature ("on-the-fly" processing)

50+ Raster Functions
Raster Function or Geoprocessing Tool?
ArcGIS Imagery Information Model

• Geoprocessing Tools
  - Esri does not implement what I need as a Raster Function
  - My processing requires integration of feature data (vectors)
  - I have complex GP Models (conditionals, iterations, custom script tools)
  - Algorithms which are not well suited for block level processing (cost distance)

• Raster Functions
  - If you can, you should (storage savings, time savings, flexibility to change,..)
  - Esri provides all the Raster Functions I need to produce my products
  - It’s acceptable in my application to use an ephemeral or intermediate results
    - Visualization
    - Analysis results which can be consumed per request based on an AOI
Demo
Raster Function
Raster Product
ArcGIS Imagery Information Model

- The Raster Product is the primary information model component which makes it easy to use intelligence which is provided by the Raster Type
- It’s role is to represent Imagery Information Model intelligence as products and product information to the user
- A Raster Product
  - enables ArcGIS user interface shortcuts to well known band combinations and processing chains
  - allows the user to think about products and not files

Sensor and/or Format Specification specific
they are based on Raster Type(s)

- ArcMap Catalog window / ArcCatalog
The Mosaic Dataset is the primary information model component which manages massive collections of imagery.

It's role is to provide...

- an image library for management (cataloging, indexing, metadata, searching, …)
- dynamic, on-the-fly, product generation (mosaicking, processing and analysis)
- a workflow to shorten the time from sensor to use (quickly ingest, dynamic product immediately available)

Scalable (1 to millions of images)

homogeneous or heterogeneous collections (one sensor or a mix)

Dynamic product generation for visualization or analysis
The Image Service is the primary information model component which web enables imagery. It’s role is to provide *Imagery as a Service* (one aspect of GIS as a Service).
Putting it all together

Collection

Raster Types

Imagery
Native Form

Harvests Metadata

Mosaic Dataset

Points
to original Imagery

Raster Functions

Raster Products

ArcGIS Server

Image Service

Desktop

Web

Device

ArcGIS Desktop

Publishing
What can I do with imagery in ArcGIS?
What are my choices when working with imagery

ArcGIS and Imagery

- **One image at a time**
  - Files
  - Image Analysis Window (IAW)
  - Geoprocessing
- **Collections of images**
  - Mosaic Datasets
  - Image Analysis Window (IAW)
  - Geoprocessing
- **Imagery as a Service**
  - Web
  - Image Analysis Window (IAW)
  - Developer APIs
  - ArcGIS Online
Processing, Exploitation, Dissemination
ArcGIS and Imagery

- 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
  - 95+ tools for image management and processing
- Raster Functions
  - Can be applied to Raster Datasets, Mosaic Datasets, and Image Services
Processing, Exploitation, Dissemination
ArcGIS and Imagery

- **Take advantage of ArcGIS ready-to-use imagery**
  - ArcGIS Online World Imagery Base Map, Landsat GLS, Landsat 8, NAIP
  - Consume Premium Services available by Partners on the ArcGIS Marketplace
- **Visualize images**
  - as a single image
  - as a dynamically mosaicked product
- **Extract feature data from imagery**
  - manually capture features using imagery as a backdrop
  - image classification
  - custom image processing with R2V and vector tools for cleanup
- **Take measurements (Mensuration Tools)**
Processing, Exploitation, Dissemination

ICS provides an undistorted view in natural orientation

**did you know?**

Geographic Coordinate System - GCS

Image Coordinate System - ICS

*Map on an Image... vs. Image on a Map...*
Demo
Image Coordinate System
Processing, Exploitation, Dissemination
ArcGIS and Imagery

- Create multiple products from a single source without the additional storage resource costs
Make basic to advanced products accessible in the enterprise and on the web.
Summary
ArcGIS is an imagery platform for GIS (and pure PED)

- Imagery is an integral aspect of GIS
- Imagery is readily available
- ArcGIS comes with imagery
- ArcGIS provides advanced imagery tools
- ArcGIS can manage massive image collections
- Spend time understanding the information model and technologies of ArcGIS
  - Reference Documentation, Resource Center, Blogs, Workshops, Webinars
- Outside the scope of this presentation...
  - Learn more about our Imagery Business Partners
Want to learn more?

• UC 2015
  - Managing Imagery and Raster Data Using Mosaic Datasets
    - Room 32A, Tuesday 3:15 & Wednesday 1:30
  - Imagery Island (Showcase)

• Documentation

• Get Involved
Thank you…

- Please fill out the session survey in your mobile app
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  - use the Search Feature to quickly find this title
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- Answer a few short questions and enter any comments