Imagery Sources and Usage in ArcGIS

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Imagery...

- ... is visible intelligence
Agenda

• Imagery basics
• Sources of imagery
  - Platforms and sensors
  - Living Atlas
• Image usage
  - Image Storage
  - Image processing in ArcGIS Pro
  - Image Analysis techniques in ArcGIS Pro
• LAS Datasets
• Visualization
Spectral bands

- We know:
  - Sunlight consist of more wavelengths of electromagnetic radiation than the human eye can see
    - e.g. sunburn
- Bands: A specific range of wavelengths of electromagnetic radiation
Image bands

- Single Band
- Multispectral
Types of Imagery: single band

- Grayscale imagery
- Digital Elevation Models (DEM)
  - Digital Terrain Models (DTM) – bare earth
  - Digital Surface Models (DSM) – height of surface features
Multispectral Imagery

- Multispectral

Natural Color

Color Infrared

NDMI

NDVI

Electromagnetic spectrum
Sensor Platforms

- Platforms
  - Satellites
  - Aircrafts
  - Drones (UAVs)
  - Ground based / handheld
Sensors

- **Sensors**
  - Passive – record reflected sunlight
    - Cameras
    - Spectrometers
  - Active – emit energy and record reflected radiation
    - Lidar
    - Radar
    - Sonar
Demo: Image Sources
Image Services

- Provides imagery as a service

- Pictures
- Pixels
- Metadata
- Upload/Download
Image storage: Mosaic Dataset

- Source raster stored in a folder
- Mosaic dataset stored in a geodatabase
Usage: Image Analysis

- Landcover classification
- Change detection
- Suitability Analysis
- Crop Health
- Visibility Analysis
- Hydrological Analysis
Imagery applications

- Engineering and Construction
- Climate and weather study
- Humanitarian Aid
- Forestry
- Natural Disaster Management
- Precision Agriculture
Raster Functions

- Apply an algorithm on-the-fly to an existing raster/image layer (raster dataset or mosaic dataset)
- Can be applied to a pixel or block of pixels (segment)
- Can be chained into Raster Function Chains

![Diagram showing Raster, Geoprocessing, Symbology, and Transform]

Raster dataset → Geoprocessing → Symbology → Transform
Image Processing: Raster functions

- Raster functions can:
  - Transform the data
  - Alter symbology properties
  - Replicate geoprocessing tools

<table>
<thead>
<tr>
<th>Quality</th>
<th>Geoprocessing tool</th>
<th>Raster function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has quick processing speed</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Does not modify input data</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Adjusts input parameters after processing</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Can be used in process chain</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Demo: Image Analysis in ArcGIS Pro
LiDAR Background

- **LiDAR – Light Detection and Ranging**
  - Optical remote sensing technique using laser light to densely sample the Earth’s surface, producing a point cloud of highly accurate x,y,z measurements
  - Originated in the 1960s; Supported in ArcGIS since version 10.1
- **Types of Point Clouds**
  - Airborne scanned-based LiDAR
  - Airborne Geiger mode LiDAR
  - Mobile / Tripod-based LiDAR
  - Photogrammetric point clouds
- **LiDAR point cloud attributes**
  - x,y,z measurements
  - Intensity
  - Return number
  - Class code
  - RGB
- LAS is the default data structure for working with LiDAR point clouds
  - LAS is an industry-standard, binary file format developed by ASPRS
  - LAS/zLAS can be used individually now (~Pro 1.4)
The LAS Dataset

- **LAS Dataset**
  - “Container” for storing reference to many LAS/zLAS files on disk
    - Pointer to the original LAS/zLAS files
    - Quick to create, small in file size, easy to update with additional LAS/zLAS files
  - Quick display of LAS/zLAS data as point clouds or a dynamic TIN in 2D or 3D
  - Excellent for QA/QC of LiDAR coverage (point density/spatial extent)
  - Basis for generated products such as DEMs and DSMs or TINs
  - Recommend Tiled LAS tool for large LAS files
Working with LiDAR in ArcMap

Symbolize points
Working with LiDAR in ArcMap

Symbolize by surface
Working with LiDAR in ArcMap
Working with LiDAR in ArcMap
Working with LiDAR in ArcMap

3D view
Working with LiDAR in ArcMap

- 3D Sample Tools
  - Conversion
    - ASCII Text To LAS
    - LAS Dataset To Point
    - LAS Dataset To Tiled Rasters
    - LAS File Extent As Polygon
    - LAZ To LAS
  - Mosaic To LAS Dataset
  - Terrain To Tiled Rasters
  - TIN To LandXML
  - TIN to Multipatch
  - zLAS To LAZ

- Feature Analysis
  - Adjust Multipatch Z
  - Cast Shadows On Raster
  - Contour Multipatch
  - Create Sun Sightlines
  - Create Sun Skymap
  - Cross Section Lines
  - Cross Section Polygons
  - Explode Multipatch
  - Simplify 3D Line

- Lidar Analysis
  - LAS Building Multipatch
  - LAS Building Polygon
  - LAS Overlap Areas
  - LAS Point Statistics By Area
  - Locate LAS Points By Proximity
  - Sample Z From LAS

- Lidar Classification
  - Classify LAS By Height
  - Classify LAS Ground Points
  - Classify LAS Model Key Points
  - Classify LAS Noise
  - Classify LAS Overlap Points
  - Classify LAS Rooftop Points

- Lidar Management
  - Check LAS
  - Colorize LAS
  - Convert LAS Version
  - Create PRJ for LAS
  - Delete PRJ For LAS
  - EzLAS Optimizer
  - LAS File Information
  - LAS Reporter
  - LAS To LAS
  - Rearrange LAS Points
  - Reference LAS Subset
  - Split LAS Points
  - Thin LAS

- TIN
  - Closest TIN Node
  - Create Fence Diagram
  - Extract TIN
  - Integrate TINs
  - Set TIN Node Z

- Vegetation Analysis
  - Canopy Peaks
  - LAS Height Metrics As Raster
  - Tree Crown Extent
  - Tree Crown Radius

https://www.arcgis.com/home/item.html?id=fe221371b77940749ff96e90f2de3d10
Working with LiDAR in ArcGIS Pro

LAS dataset point symbology

LAS dataset filter
Demo #1:

• Find LiDAR data on USGS EarthExplorer
• Create and explore a LAS Dataset
Working with LiDAR in a Mosaic Dataset

• LAS datasets can be directly read into the Mosaic Dataset
  - Use Raster functions or other tools (i.e. Viewshed, Contour, Profile)
  - Used as a DEM
  - Used to orthorectify imagery
  - Used in applications that support rasters but not LAS files or LAS datasets

Raw Las files

<table>
<thead>
<tr>
<th>File Path</th>
</tr>
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<tbody>
<tr>
<td>MA_ME_MA_QL2_UTM19_L1_2015_000074.las</td>
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<tr>
<td>MA_ME_MA_QL2_UTM19_L1_2015_000075.las</td>
</tr>
<tr>
<td>MA_ME_MA_QL2_UTM19_L1_2015_000089.las</td>
</tr>
<tr>
<td>MA_ME_MA_QL2_UTM19_L1_2015_000174.las</td>
</tr>
</tbody>
</table>

LAS Dataset

WorcesterMA.lasd

Mosaic Dataset:
Ground (Class 2) Filter
Worcester_DEM

Mosaic Dataset:
First Return Filter
Worcester_DSM
Demo #2:

• Add LiDAR data to a Mosaic Dataset
• Use Raster functions on a Mosaic Dataset to create a Normalized Difference Surface Model (nDSM)
LiDAR and Geoprocessing in ArcGIS Pro

Data Management Tools
- LAS Dataset
  - Add Files To LAS Dataset
  - Create LAS Dataset
  - LAS Dataset Statistics
  - LAS Point Statistics As Raster
  - Remove Files From LAS Dataset
- Make LAS Dataset Layer

3D Analyst Tools
- LAS Dataset
  - Change LAS Class Codes
  - Classify LAS Building
  - Classify LAS By Height
  - Classify LAS Ground
  - Classify LAS Noise
  - Classify LAS Overlap
  - Extract LAS
  - LAS Point Statistics By Area
  - Locate LAS Points By Proximity
  - Set LAS Class Codes Using Features
  - Tile LAS
- LAS Building Multipatch

Conversion Tools
- LAS To Multipoint
- LAS Dataset To TIN
- LAS Dataset To Raster
Demo #3:

- Extract height values to building footprints from LiDAR
- Apply a Rule Package to create textured, realistic 3D buildings
## Considerations for working with a LAS dataset

This table summarizes several factors that you should consider before building a LAS dataset.

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate system</td>
<td>* Data recommended to be delivered and consumed in a projected coordinate system.</td>
</tr>
<tr>
<td></td>
<td>* If no spatial reference is present or if the LAS file has an incorrect spatial reference, add an accompanying projection file (.prj) file with a LAS file referenced by the LAS dataset.</td>
</tr>
<tr>
<td>Height measurements</td>
<td>* Use orthometric heights.</td>
</tr>
<tr>
<td>Lidar data types supported</td>
<td>* Use classified lidar data.</td>
</tr>
<tr>
<td></td>
<td>* Surface constraint data can be photogrammetrically derived breaklines or GPS points.</td>
</tr>
<tr>
<td>Data storage</td>
<td>* Store the data locally.</td>
</tr>
<tr>
<td></td>
<td>* Limit 1 to 2 million data points per every LAS file.</td>
</tr>
<tr>
<td></td>
<td>* Limit file size to 25 to 50 MB, and no larger than 100 MB.</td>
</tr>
<tr>
<td>Version</td>
<td>* Tiled LAS with version 1.1 or later to access predefined classification codes.</td>
</tr>
<tr>
<td>Advantage</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Dynamic mosaicking</td>
<td>Stores multiple collections and projects:</td>
</tr>
<tr>
<td></td>
<td>* Projections</td>
</tr>
<tr>
<td></td>
<td>* Formats</td>
</tr>
<tr>
<td></td>
<td>* Resolution</td>
</tr>
<tr>
<td>Elevation data storage</td>
<td>* Topographic data</td>
</tr>
<tr>
<td></td>
<td>* Bathymetric data</td>
</tr>
<tr>
<td></td>
<td>* Raster data</td>
</tr>
<tr>
<td></td>
<td>* Point data</td>
</tr>
<tr>
<td>On-the-fly processing</td>
<td>Processes image as accessed:</td>
</tr>
<tr>
<td></td>
<td>* Stretch, extract bands</td>
</tr>
<tr>
<td></td>
<td>* Clip, mask</td>
</tr>
<tr>
<td></td>
<td>* Reproject, orthorectify, pan-sharpen</td>
</tr>
<tr>
<td></td>
<td>* Shaded relief, slope, aspect</td>
</tr>
<tr>
<td>Data access</td>
<td>* As raster</td>
</tr>
<tr>
<td></td>
<td>* As source data</td>
</tr>
<tr>
<td></td>
<td>* As data shared internally and online</td>
</tr>
</tbody>
</table>