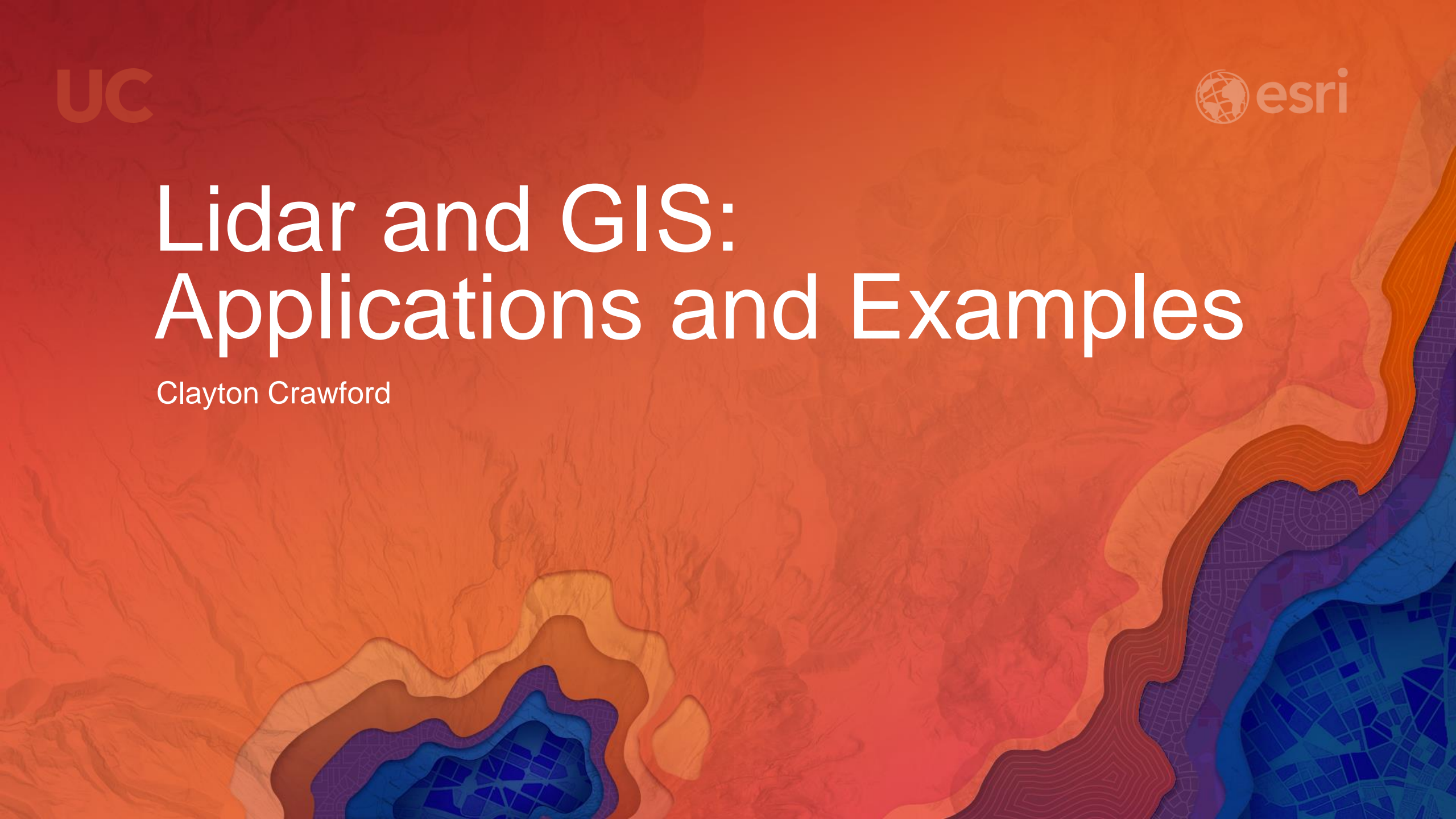


Lidar and GIS: Applications and Examples

Clayton Crawford



Outline

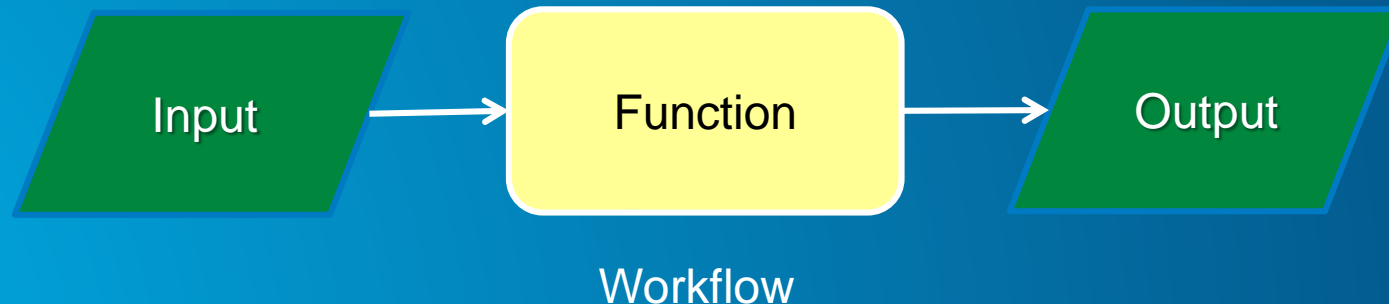
- **Data structures, tools, and workflows**
- **Assessing lidar point coverage and sample density**
- **Creating raster DEMs and DSMs**
- **Data area delineation**
- **Estimating forest canopy density and height**
- **Creating intensity images**
- **Reducing noise for contouring and slope analysis**
- **Floodplain delineation**

Big Picture

- **Solutions for GIS end users**
 - **Not about lidar data production**
- **Operate on clean/classified lidar points**
- **Produce useful derivatives**
- **Perform analysis**
- **Handle large datasets**
- **Both file and database oriented solutions**

Supporting Data structures and Tools

- **Vector features**
 - points
 - multipoints
 - lines
 - polygons
 - multipatches
- **Raster**
- **TIN**
- **Terrain Dataset**
- **Point File Information**
- **LAS To Multipoint**
- **ASCII 3D To Feature Class**
- **Point To Raster**
- **Terrain To Raster**
- **Terrain To TIN**



Supporting Data structures and Tools

- **LAS dataset**

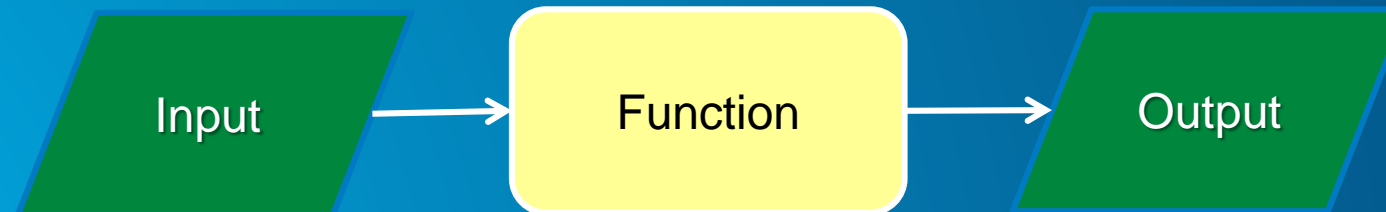
- LAS Dataset Statistics
- LAS Dataset To Raster
- LAS Point Statistics As Raster
- LAS Point Statistics By Area
- LAS Dataset To TIN
- Set LAS Class Codes Using Features

- **LAS dataset...**

- Change LAS Class Codes
- Classify LAS By Height
- Classify LAS Ground
- Extract LAS
- Locate LAS Points By Proximity

- **Mosaic dataset**

- Extensive collection of raster tools



Workflow

Lidar Point Coverage and Sample Density

- Basic QA/QC before loading data into geodatabase
- Verify xy and z extent
- Examine point spacing

Name	Date modified	Type	Size
Tile000023.las	10/30/2008 12:13 ...	LAS File	264,438 KB
Tile000024.las	10/30/2008 12:14 ...	LAS File	367,523 KB
Tile000025.las	10/30/2008 12:15 ...	LAS File	340,340 KB
Tile000026.las	10/30/2008 12:16 ...	LAS File	85,184 KB
Tile000035.las	10/30/2008 12:22 ...	LAS File	132,955 KB
Tile000036.las	10/30/2008 12:23 ...	LAS File	485,083 KB
Tile000037.las	10/30/2008 12:24 ...	LAS File	390,750 KB
Tile000038.las	10/30/2008 12:25 ...	LAS File	350,254 KB
Tile000039.las	10/30/2008 12:26 ...	LAS File	255,534 KB
Tile000040.las	10/30/2008 12:26 ...	LAS File	147,637 KB

= ?

LAS Dataset Layer

The screenshot shows the ArcGIS Pro interface with a LAS Dataset Layer. The main map area displays a red grid pattern. A pop-up window is open, showing the following metadata for the selected LAS file:

Pop-up

- PA_Centre_County.lasd (1)
 - LAS File: 30001960PAN.zlas

PA_Centre_County.lasd - LAS File: 30001960PAN.zlas

File	72
Index	
LAS File	30001960PAN.zlas
Location	Z:\3DTeam\LIDAR_Data\Pennsylvania\Ce
LAS Version	1.0, point format 1
Point Count	5,532,935
Point Spacing	4.249 ft
Z-Range	645.840 to 1621.780 ft
Statistics	Current
Has RGB	No

Coordinates: 1,965,247.08E 294,746.35N ftUS

Scale: 1:390,824

Selected Features: 0

LAS Dataset Properties

LAS Dataset Properties: laguna_niguel.lasd

General
Statistics
LAS Files
Surface Constraints
Coordinate System

Files

Show: Files Show full path of LAS files

Add Files... Add Folders... Remove

LAS File	Version	Point Count	Point Spacir	Z M		
Tile000001.las	1.2	4,185,584	2.752	-132		
Tile000002.las	1.2	4,385,886	2.79	163.2		
Tile000003.las	1.2	4,443,149	2.754	208.3		
Tile000004.las	1.2	4,516,182	2.672	306.4		
Tile000005.las	1.2	4,594,846	2.712	-146		
Tile000006.las	1.2	3,932,164	2.841	270.43	4117.54	...
Tile000007.las	1.2	4,055,510	2.852	-1293.0	4443.3	...
Tile000008.las	1.2	3,753,963	2.924	-888.17	4304.19	...
Tile000009_exported.las	1.2	3,187,189	2.767	269.3	2713.12	...

OK Cancel

LAS Dataset Properties: laguna_niguel.lasd

General
Statistics
LAS Files
Surface Constraints
Coordinate System

Statistics for: Tile000001.las

General Classification Codes Extent Returns Attributes

Name	Tile000001.las
Version/Point Format	1.2 / 1
Point Count	4,185,584
File Size	117,196,581 bytes
Is Rearranged	No
XY Coordinate System	NAD_1983_StatePlane_California_VI_FIPS_0406_Feet
Z Coordinate System	NAVD_1988
X,Y,Z Offsets	0.000000, 0.000000, 0.000000
Model Key Points	0
Synthetic Points	0

Update Force recalculate

OK Cancel

Point File Information Tool

- Inputs files (LAS and ASCII) and folders of files and outputs a polygon feature class.
- Each output record includes
 - Polygon of file's data extent
 - Source filename
 - Point count
 - Point spacing estimate
 - Z min
 - Z max

The screenshot shows the 'Point File Information' tool in the Geoprocessing environment. The interface includes a 'Parameters' tab and an 'Environments' section. The 'Point Data' field is set to 'E:\Data\FL_Plant_City\Las_Files'. There is an 'Include Subfolders' checkbox which is unchecked. The 'Output Feature Class' is 'zLAS_PointFileInformation'. The 'File Format' is set to 'LAS format lidar'. The 'File Suffix' is 'LAS'. The 'Coordinate System' is currently empty. There are two checkboxes at the bottom: 'Summarize by class code' (checked) and 'Extrude Geometry Shapes' (unchecked). A 'Run' button is at the bottom right. Two yellow callout boxes provide additional information: one pointing to the 'Point Data' field stating 'You can input files or folders', and another pointing to the 'File Format' dropdown stating 'LAS and ASCII format points are supported'.

Geoprocessing

Point File Information

Parameters | Environments

Point Data

E:\Data\FL_Plant_City\Las_Files

Include Subfolders

Output Feature Class

zLAS_PointFileInformation

File Format

LAS format lidar

File Suffix

LAS

Coordinate System

Summarize by class code

Extrude Geometry Shapes

Run

You can input files or folders

LAS and ASCII format points are supported

Point File Information Tool

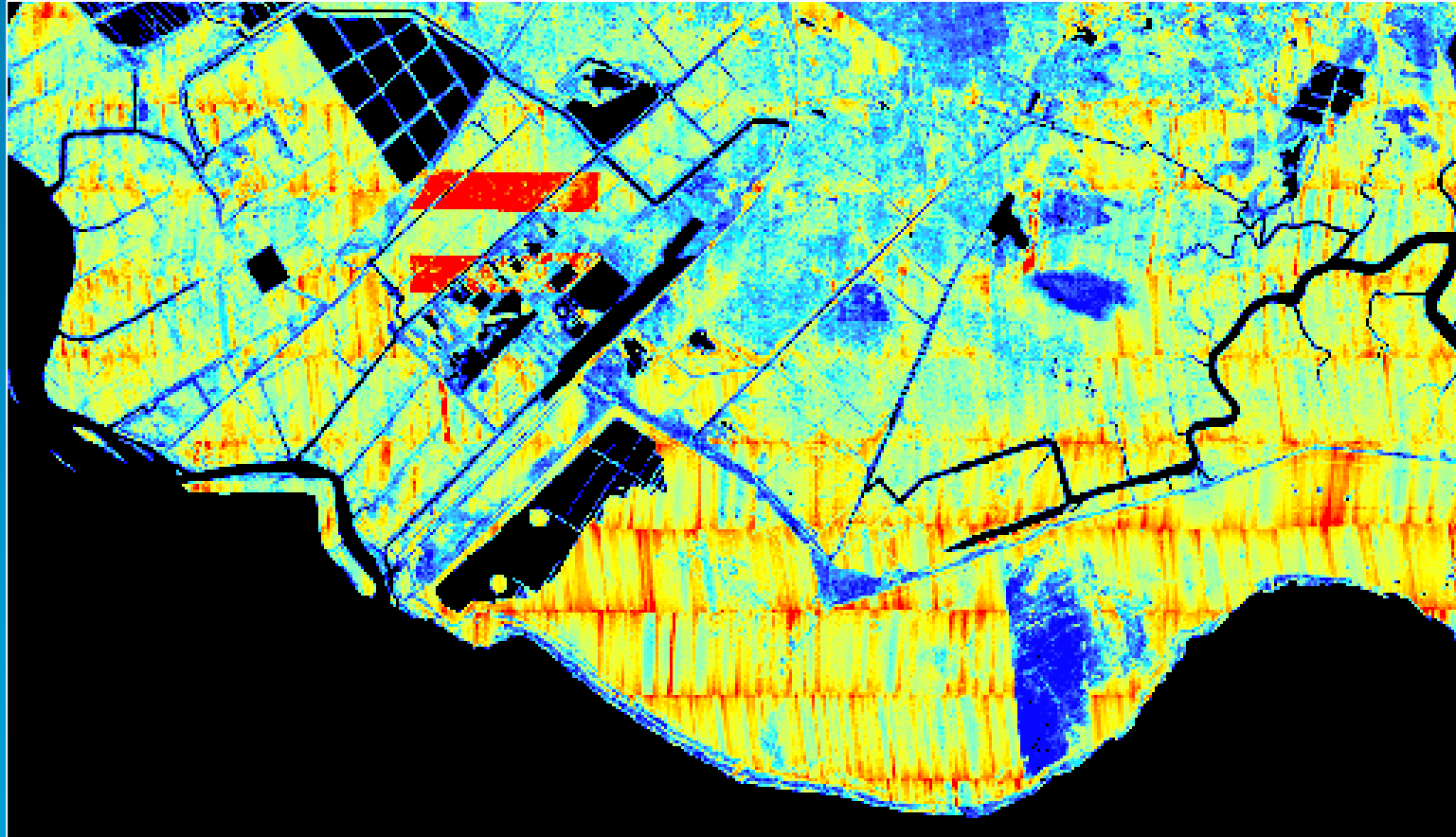
Name	Date modified	Type	Size
Tile000023.las	10/30/2008 12:13 ...	LAS File	264,438 K
Tile000024.las	10/30/2008 12:14 ...	LAS File	367,523 K
Tile000025.las	10/30/2008 12:15 ...	LAS File	340,340 K
Tile000026.las	10/30/2008 12:16 ...	LAS File	85,184 K
Tile000035.las	10/30/2008 12:22 ...	LAS File	132,955 K
Tile000036.las	10/30/2008 12:23 ...	LAS File	485,083 K
Tile000037.las	10/30/2008 12:24 ...	LAS File	300,712 K

The screenshot shows the ArcGIS Pro interface for a LAS Dataset in Jasper County. The map displays a large orange polygon representing the dataset, with a small cyan square highlighting a specific feature. The 'Contents' pane on the left shows the 'las_info' layer selected. The 'las_info' table at the bottom provides detailed information for the selected feature (OBJECTID 318).

OBJECTID	SHAPE	Name	Pt_Count	Spacing	ZMin	ZMax	SHAPE_Length	SHAPE_Area
317	Polygon	492603.las	2005921	1.059087	55.586763	389.756207	5999.96	2249970.000101
318	Polygon	492605.las	1661474	1.163701	79.205274	194.336116	5999.96	2249970.000101
319	Polygon	492606.las	1800362	1.117914	80.460023	215.571341	5999.96	2249970.000101
320	Polygon	492608.las	1563731	1.19952	87.996381	3552.043881	5999.96	2249970.000101

LAS Point Statistics As Raster Tool

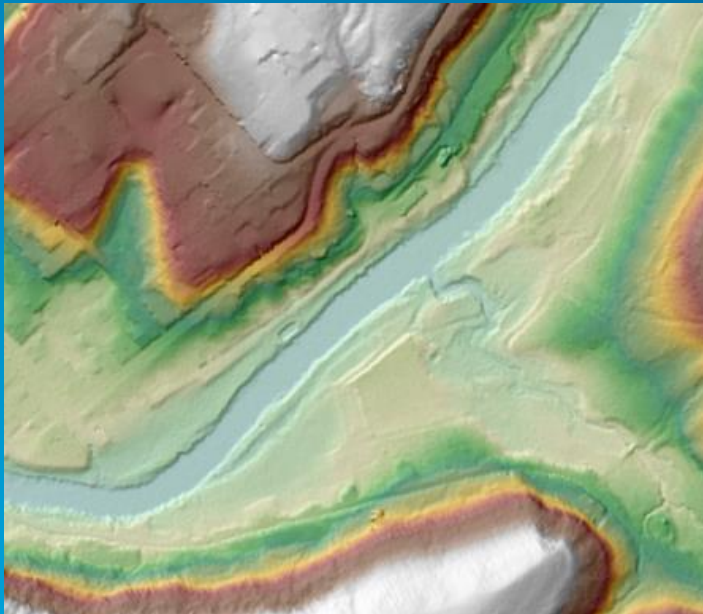
Pulse/sample density



Demo

Creating Raster DEMs and DSMs

Digital Elevation Model



Bare earth surface made using only ground hits

Digital Surface Model



Includes ground, trees, and buildings made highest hit returns

LAS Dataset To Raster

- **Binning**
 - Fast
 - Reasonable for DSMs
 - Void filling options
 - Honors replace and clip constraint types
- **Triangulation**
 - True interpolation
 - Always fills voids
 - Appropriate for DEMs
 - Honors all constraint types

Geoprocessing

LAS Dataset To Raster

Parameters | Environments

* Input LAS Dataset

* Output Raster

Value Field
Elevation

Interpolation Type: Binning

Cell Assignment: Average

Void Fill Method: Linear

Output Data Type: Floating Point

Sampling Type: Cell Size

Sampling Value: 10

Z Factor: 1

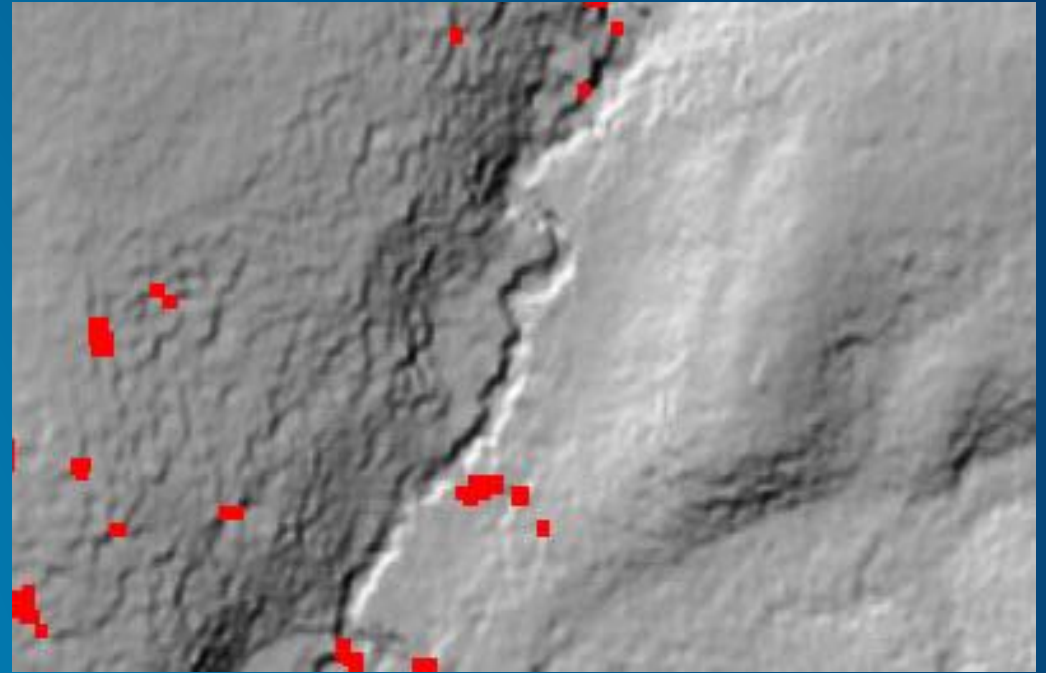
Run

Binning and Triangulation methods

Comparison

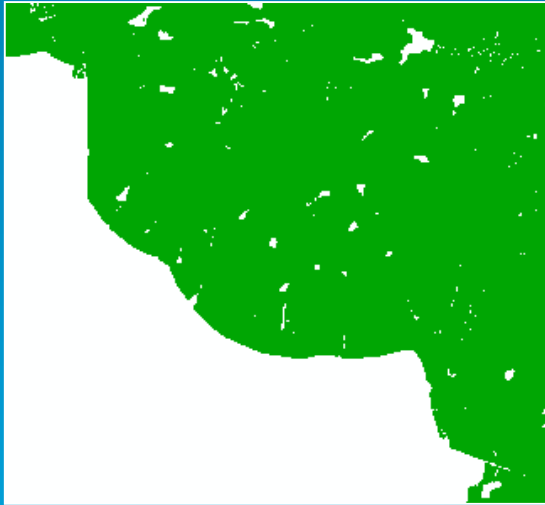


Interpolation

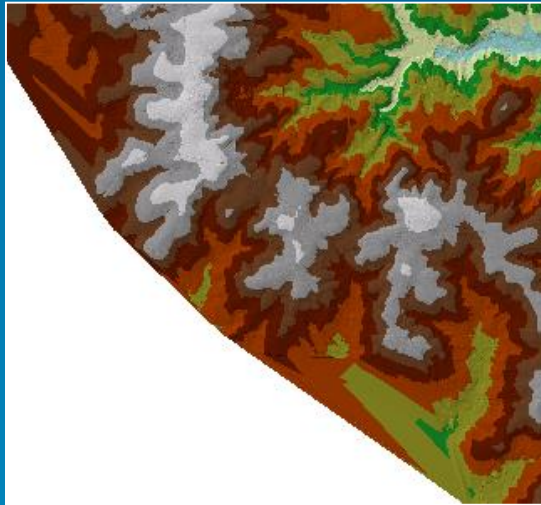


Binning

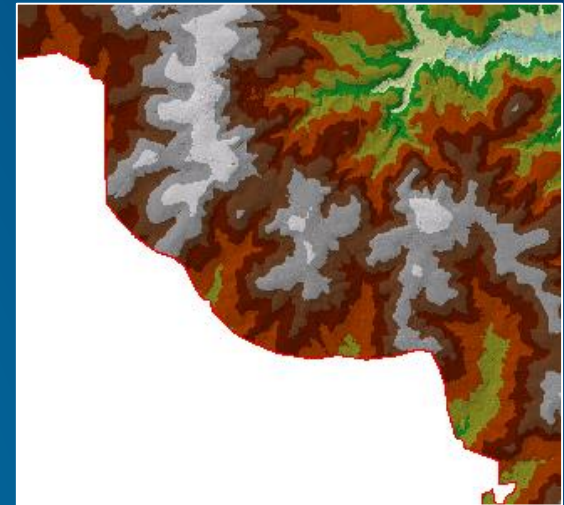
Data Area Delineation



Dense collection of
source measurement
points (green)

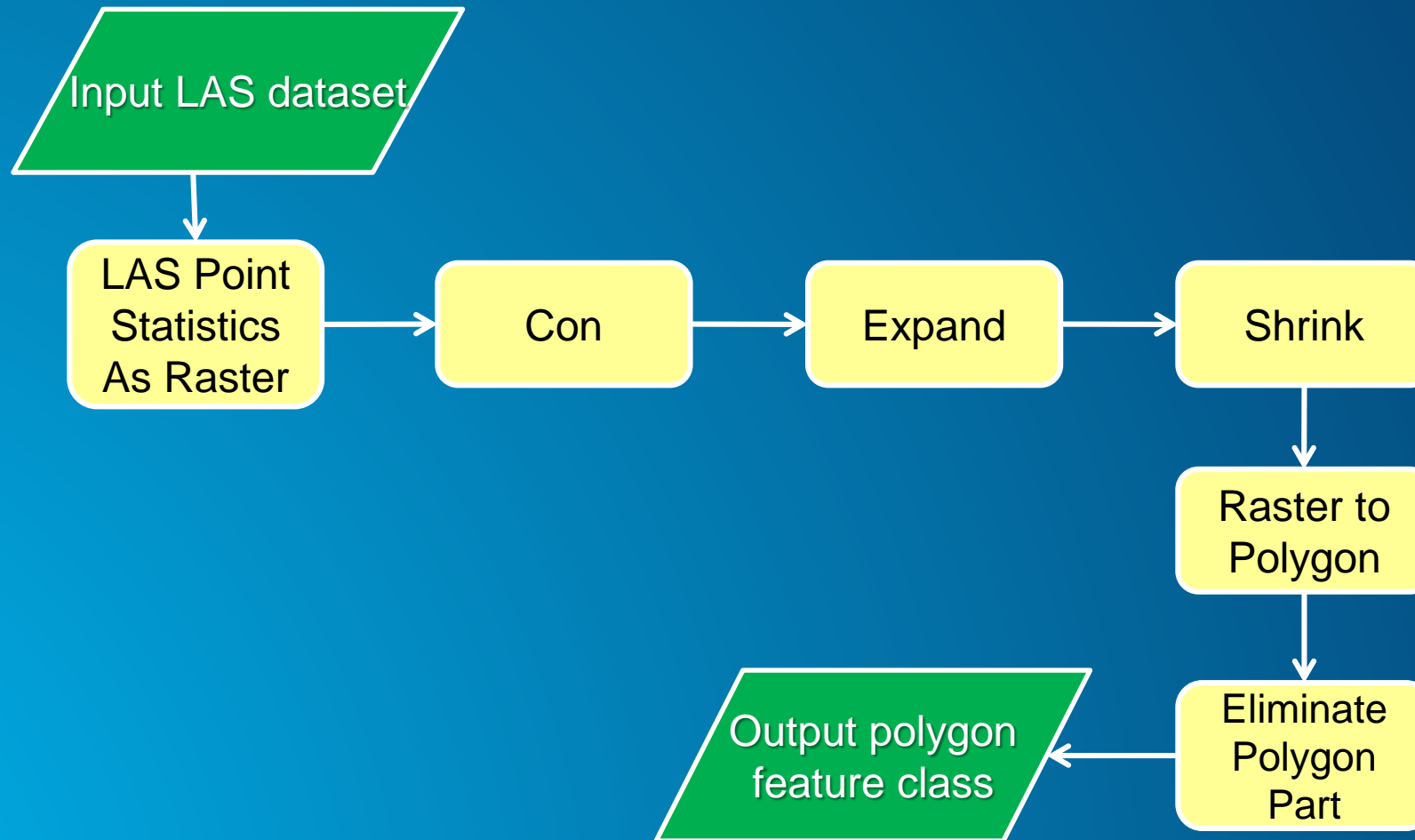


Triangulation of those
points without a
boundary constraint



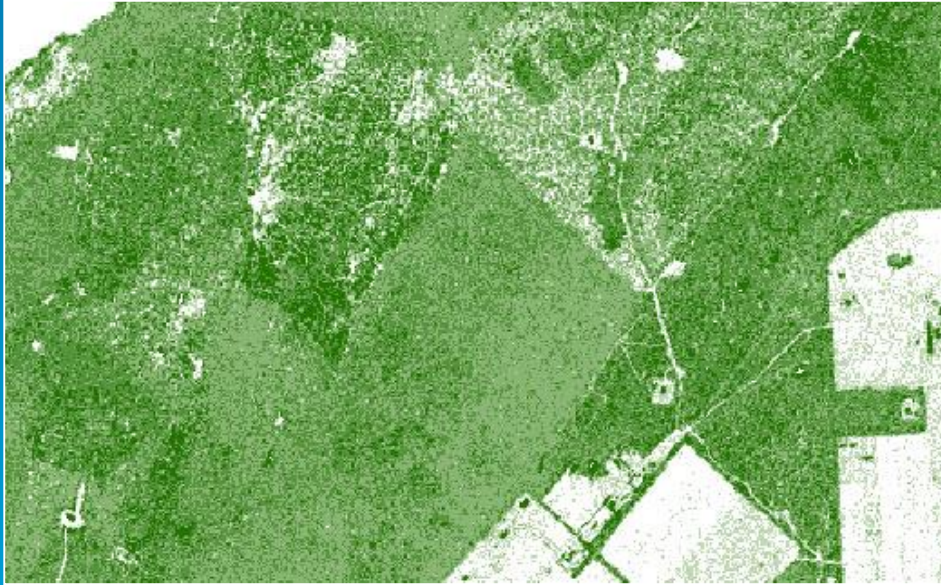
Constraint applied

Workflow to Calculate a Data Area Polygon



Demo

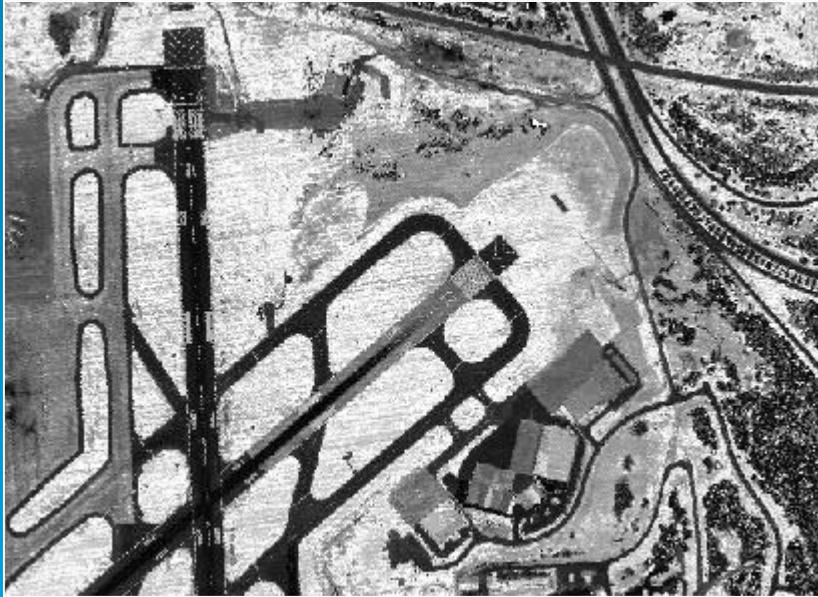
Estimating Forest Canopy Density and Height



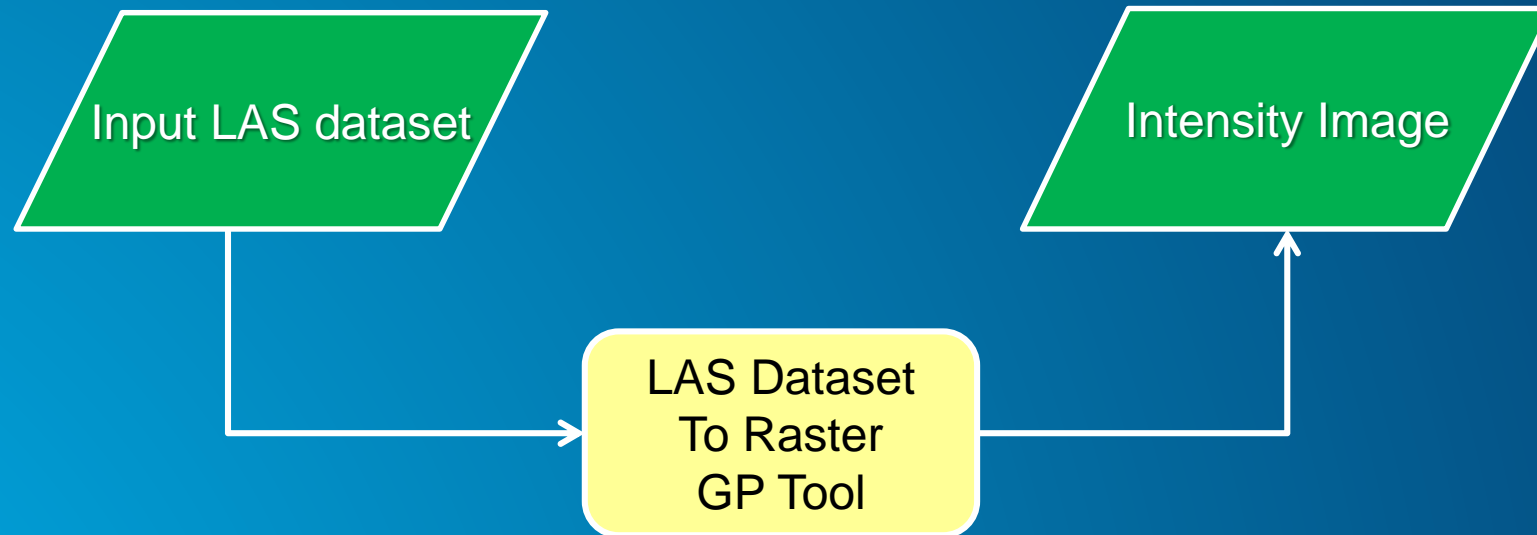
Canopy Density and Height

- **Density is the ratio of vegetation hits to total hits within a unit area (i.e., raster cell).**
 - **LAS Point Statistics As Raster to make 'count' grids**
 - **Add ground and non-ground to make a 'total' grid.**
 - **Use Divide to get the ratio between non-ground and total.**
- **Height is the difference between DSM and DEM**
 - **Sometimes referred to as normalized DEM (nDSM) or Canopy Height Model (CHM)**
 - **LAS Dataset to Raster or Terrain to Raster followed by Minus.**

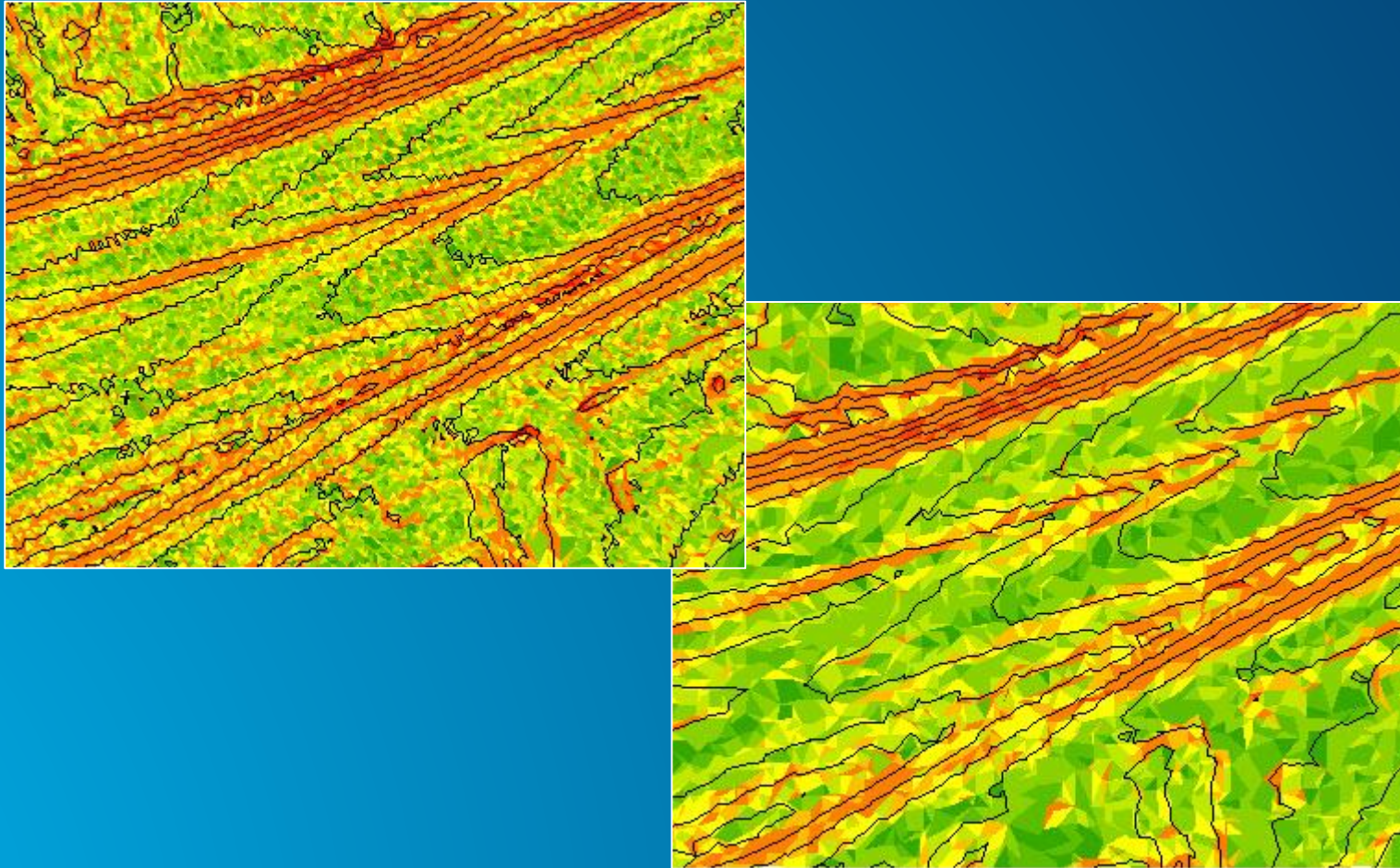
Creating Intensity Images



Intensity Image Workflow



Reducing Noise for Contouring and Slope Analysis



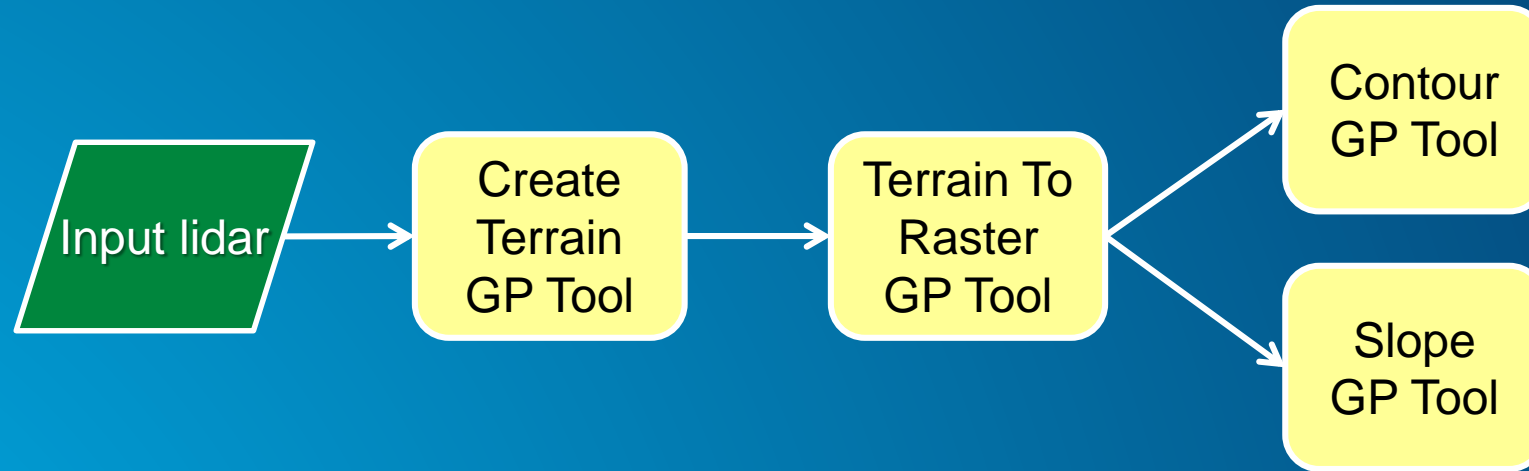
Lidar Is Noisy

- Lidar has measurement error
- Typically 12-15cm vertical accuracy
- Horizontal sample density is often 1m or less
- This results in high frequency noise
 - Extremely messy contours
 - Average slope skewed to be very high
- Goal is to reduce noise without degrading the accuracy

Point Thinning, Interpolation, and Rasterization

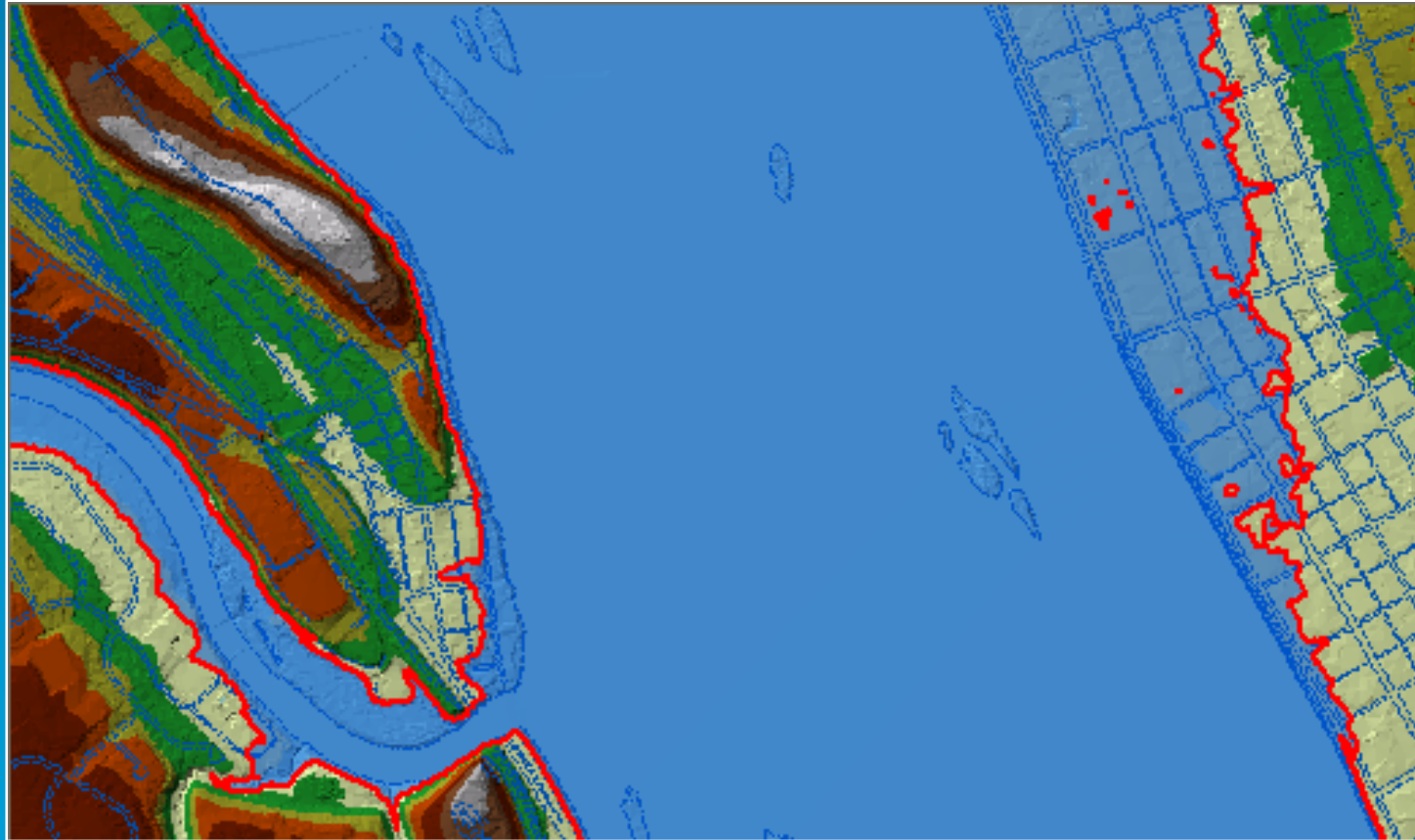
- **Use only those points necessary**
- **Some applications refer to points selected for use in making contours as ‘model key’ points**
- **Terrain pyramids**
 - Original points filtered into different levels of detail
 - Can specify which pyramid level to use when interpolating to raster or extracting TIN
- **Natural neighbors**
 - Conservatively smooth

Point Thinning, Interpolation, and Rasterization



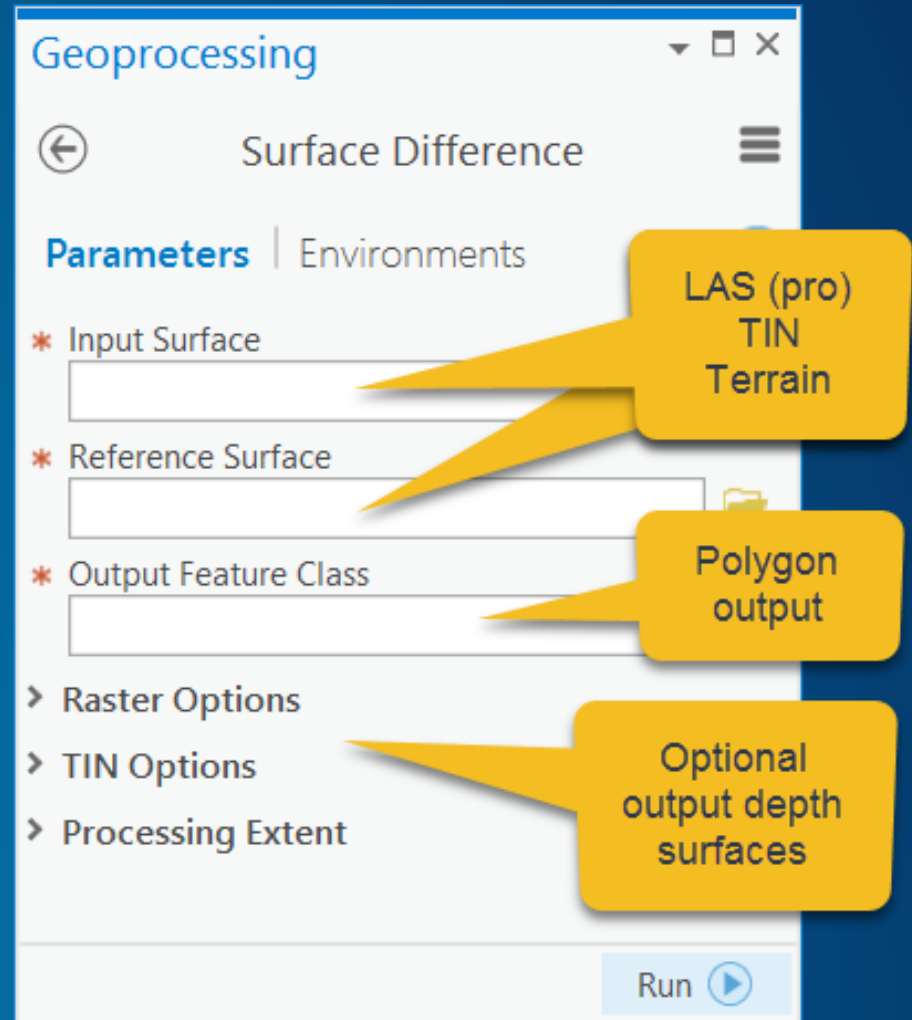
Workflow

Floodplain Delineation



Surface Difference Tool

- Subtract lidar based ground surface from modeled (e.g., HEC-RAS) water surface
- Output polygons used to delineate floodplain
- Optional output of depth surface(s)



Demo

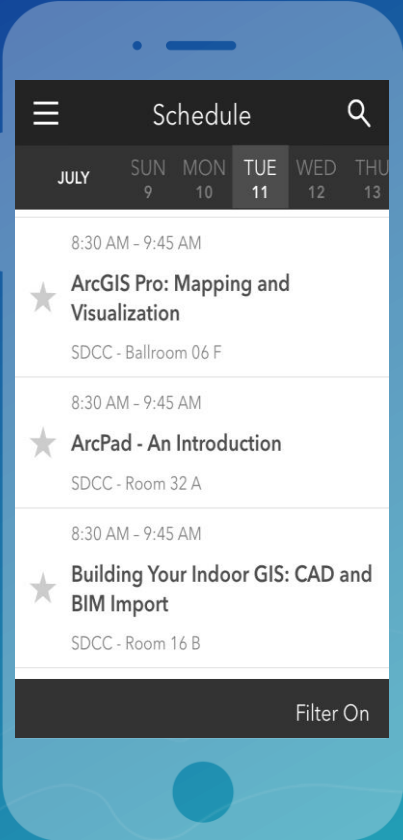
Questions?

Please Take Our Survey on the Esri Events App!

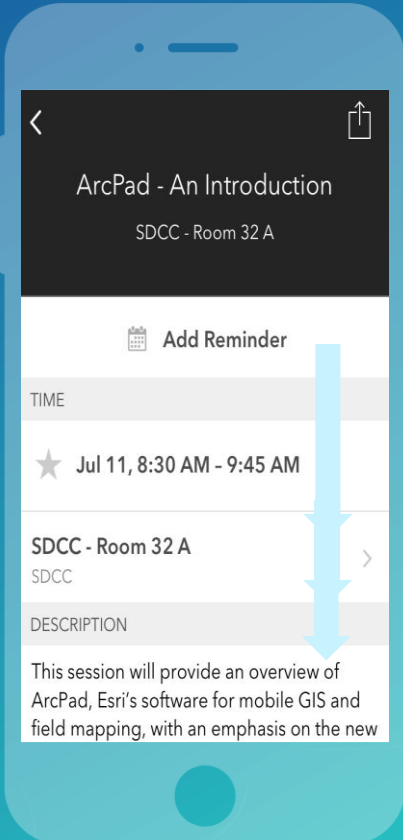
Download the Esri Events app and find your event



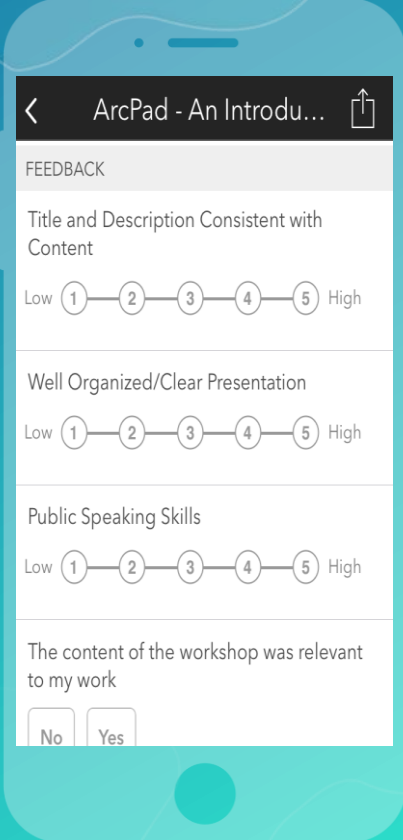
Select the session you attended



Scroll down to find the survey



Complete Answers and Select "Submit"





esri

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