

# Lidar and GIS: Applications and Examples

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# Outline

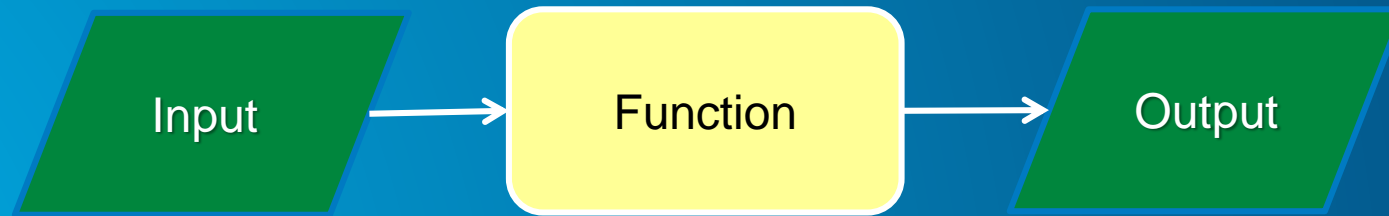
- Data structures, tools, and workflows
- Assessing lidar point coverage and sample density
- Creating raster DEMs and DSMs
- Data area delineation
- Estimating forest canopy density and height
- Floodplain delineation
- Feature Extraction for 3D City Modeling

# 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

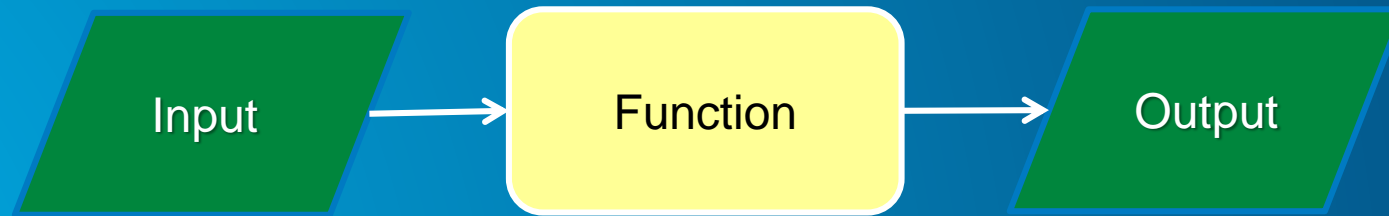
- **Vector features**
  - points
  - *multipoints*
  - lines
  - polygons
- **Raster**
- **TIN**
- *Terrain Dataset*
- **Point File Information**
- **LAS To Multipoint**
- **ASCII 3D To Feature Class**
- **Point To Raster**
- **Terrain To Raster**
- **Terrain To TIN**



Workflow

# 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

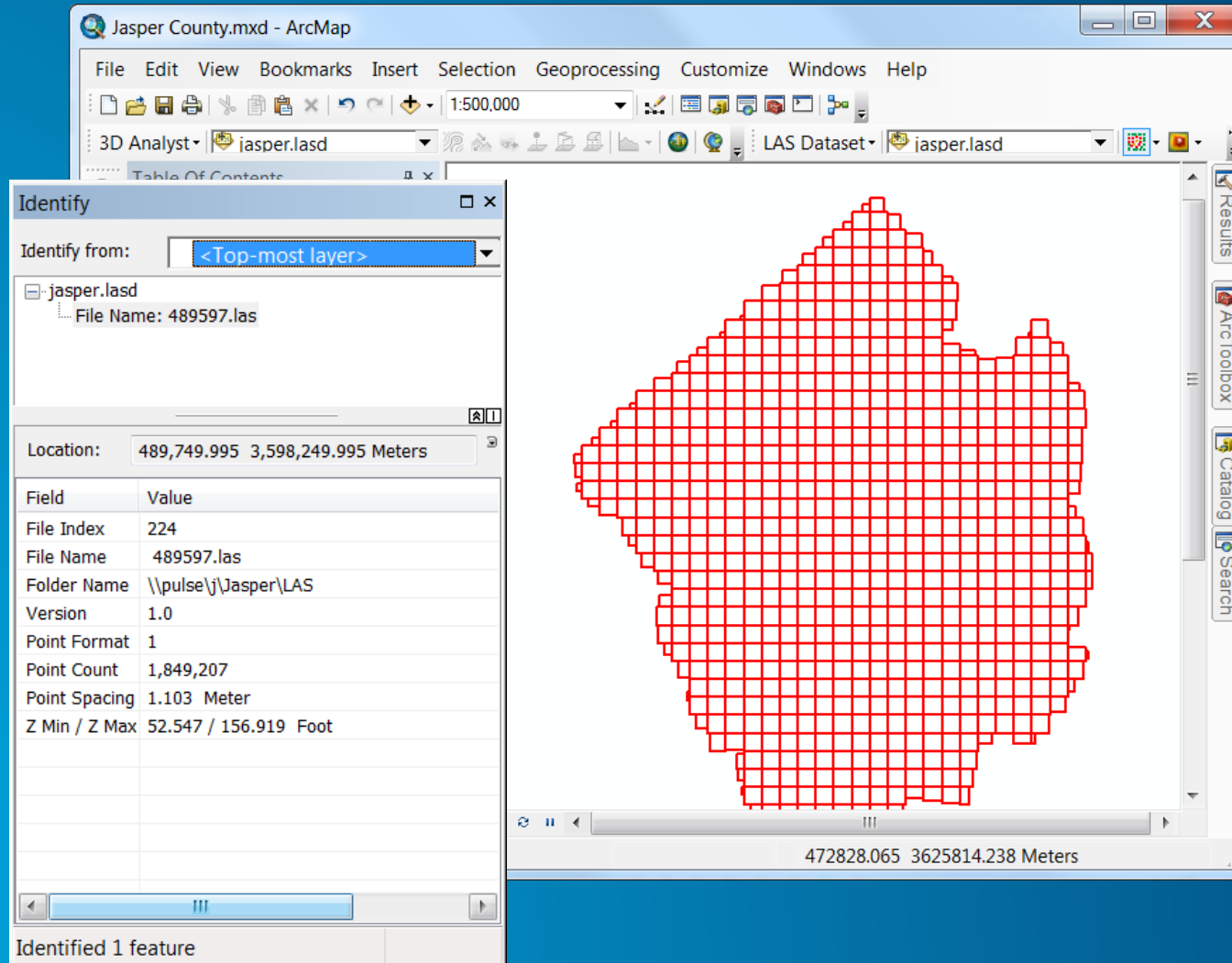
- Basic QA/QC before loading data into geodatabase
- Verify xy and z extent
- Examine point spacing

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



# LAS Dataset Properties

The image shows two overlapping dialog boxes from a software application. The background dialog is 'LAS Dataset Properties' and the foreground dialog is 'LAS File Properties and Statistics'. A red arrow points from the 'LAS File' tab in the background dialog to the 'LAS File Properties and Statistics' dialog.

**LAS Dataset Properties**

General | LAS Files | Surface Constraints | Statistics | XY Coordinate System | Z Coordinate System

Show:  ☐ Show full path of LAS files

LAS File	Version	Point Count	Point Spacing	Z Min
472599.las	1.0	206,405	1.246	18.06
472600.las	1.0	298,214	1.492	13.32
472602.las	1.0	188,594	1.585	13.32
474597.las	1.0	237,373	1.605	11.39
474599.las	1.0	1,904,058	1.087	12.83
474600.las	1.0	1,832,859	1.108	18.06
474602.las	1.0	1,961,049	1.072	22.83
474603.las	1.0	219,374	1.387	22.83
475597.las	1.0	1,534,406	1.138	11.39
475599.las	1.0	2,164,466	1.020	14.32
475600.las	1.0	2,168,471	1.019	20.83
475602.las	1.0	2,199,069	1.012	21.32
475603.las	1.0	1,740,017	1.138	23.32
475605.las	1.0	124,640	1.543	37.32
477594.las	1.0	264,015	1.447	10.32
477596.las	1.0	1,121,741	1.200	-21.32
477597.las	1.0	1,813,649	1.114	-20.83
477599.las	1.0	2,025,371	1.055	19.32
477600.las	1.0	2,239,866	1.003	20.83
477602.las	1.0	2,020,815	1.056	21.32
477603.las	1.0	1,744,430	1.136	24.32

Add Files... Add Folders... Remove

OK Cancel Apply

**LAS File Properties and Statistics**

General

Name: 472599.las  
Version/Point Format: 1.0 / 1  
Point Count: 206,405  
Spatial Reference: NAD83\_UTM\_zone\_17N  
Date Created:  
X, Y, Z Offsets: 0.000000, 0.000000, 0.000000  
X, Y, Z Scale Factors: 0.010000, 0.010000, 0.010000  
Model Key Points: 0

Extent

Min X: 473542.340000 Max X: 473999.990000  
Min Y: 3599631.800000 Max Y: 3600330.690000  
Min Z: 18.063736 Max Z: 157.558634

X Range: 457.650000  
Y Range: 698.890000  
Z Range: 139.494898

XY Linear Unit: Meter  
Z Unit: Foot

Returns

Return	Point Count	%	Z Min	Z Max
First	129,818	62.89	18.06	157.55
Second	59,630	28.89	18.32	119.14
Third	15,504	7.51	18.39	101.39
Fourth	1,453	0.70	18.16	64.15
Last	128,658	62.33	18.06	128.23
Single	69,308	33.58	18.06	128.23
First of Many	60,510	29.32	27.34	157.55

Classification Codes

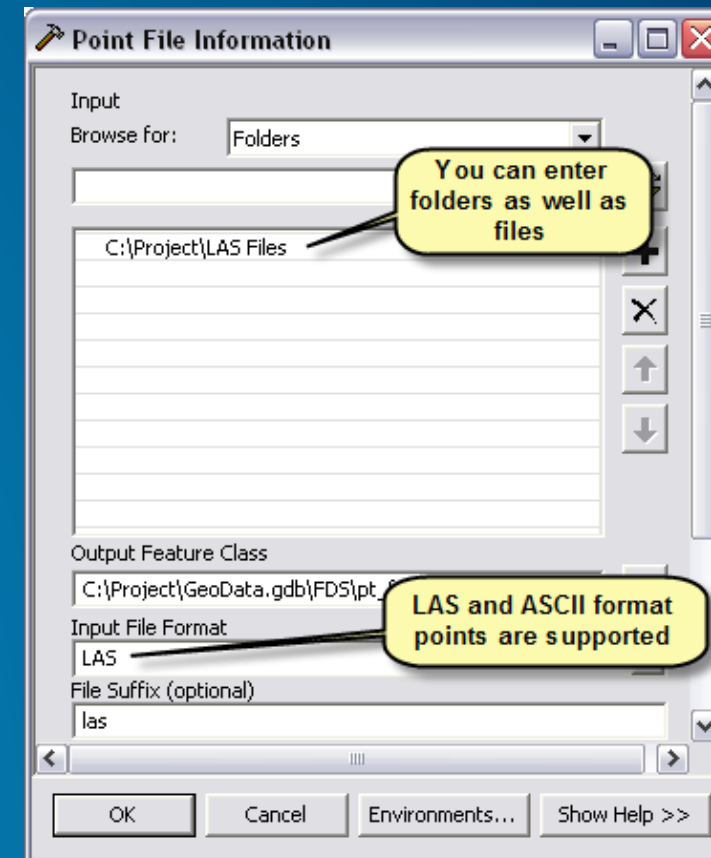
Classification	Point Count	%	Z Min	Z Max	Min Inten...	Max Inte...	Synthetic...
1 Unassigned	114,741	55.59	18.54	157.55	0	255	0
2 Ground	77,590	37.59	18.06	28.98	0	255	0
9 Water	14,074	6.82	18.27	27.82	0	255	0

Previous File Next File Update ☐ Force recalculate OK



# 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



# Point File Information Tool

Diagram illustrating the workflow of the Point File Information Tool:

1. A list of LAS files (Name, Date modified, Type, Size) is shown. An arrow points from this list to the ArcMap interface.

2. The ArcMap interface (Jasper County.mxd) displays a map with a grid overlay. A blue square highlights a specific point on the grid. An arrow points from this point to the Table window.

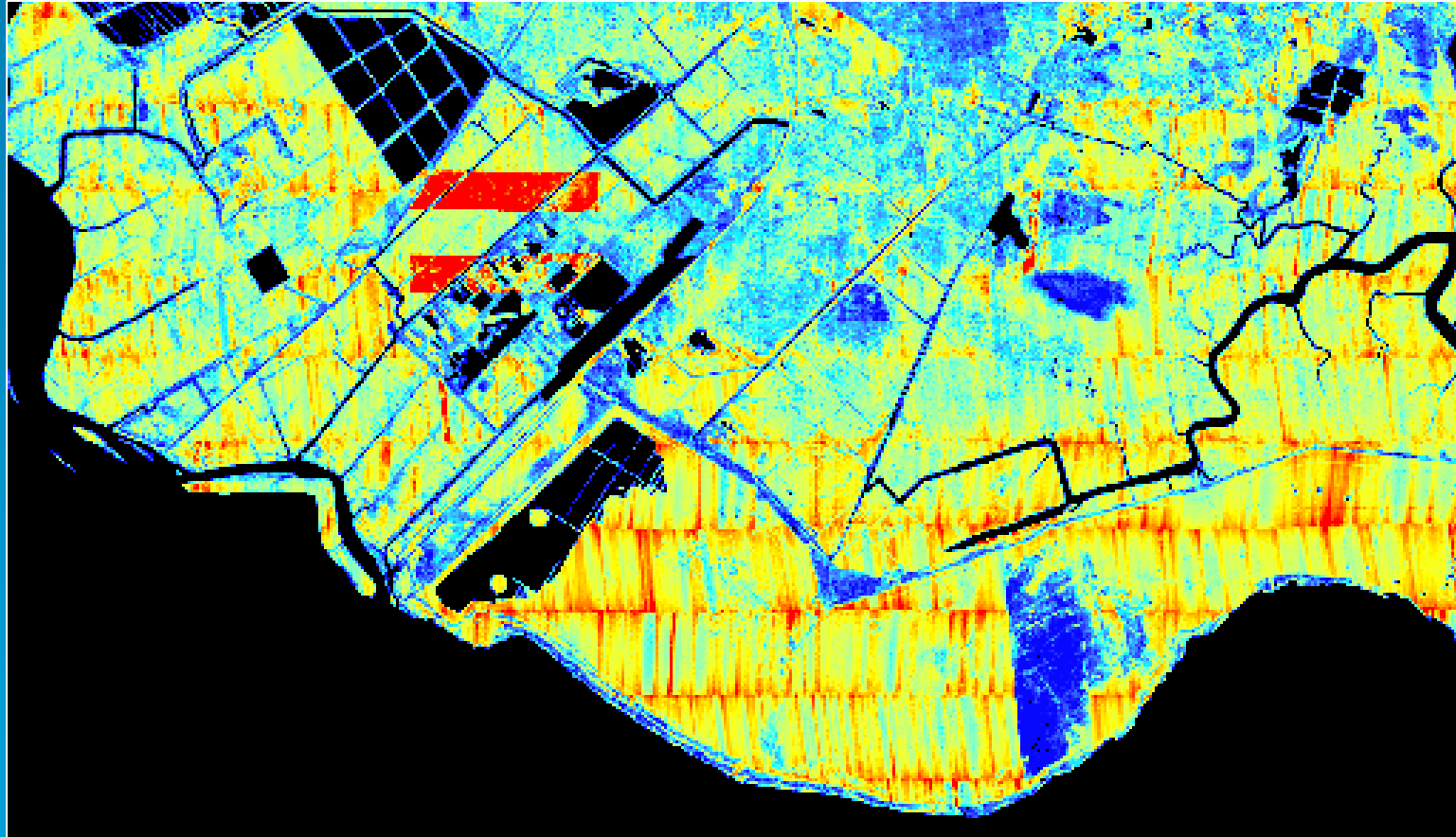
3. The Table window displays the 'LAS point info' table, showing details for the selected point (OBJECTID 359).

OBJECTID *	SHAPE *	Name	Pt_Count	Spacing	ZMin	ZMax	SHAPE_Leng
356	Polygon	493591.las	2856961	0.887437	37.699229	2008.081905	599
357	Polygon	493593.las	1951547	1.073746	41.057551	165.782592	6
358	Polygon	493594.las	2019437	1.055536	26.587318	4057.261696	599
359	Polygon	493596.las	1691486	1.153332	15.298815	169.309143	599
360	Polygon	493597.las	1681189	1.156858	44.958778	172.64269	599
361	Polygon	493599.las	1838707	1.106196	49.608659	169.238532	599

Table navigation: 1 (1 out of 880 Selected)

# LAS Point Statistics As Raster Tool

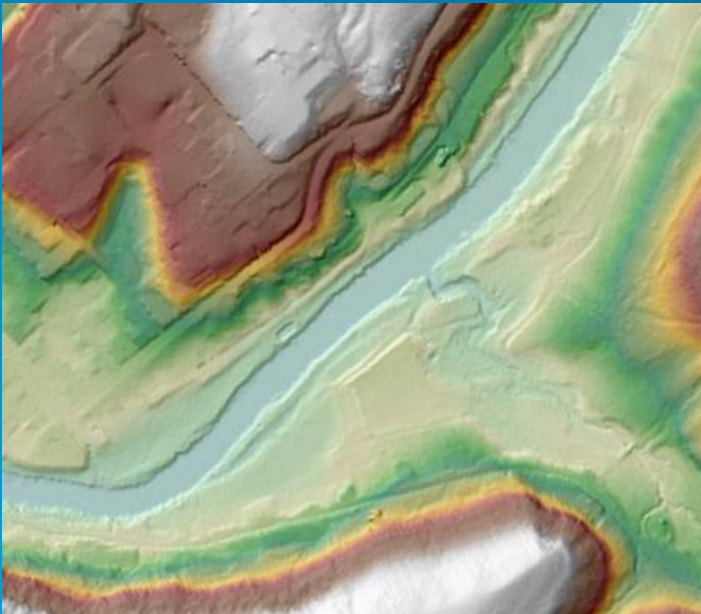
Pulse/sample density



**Demo**

# Creating Raster DEMs and DSMs

Digital Elevation Model



Bare earth surface made using only ground hits.

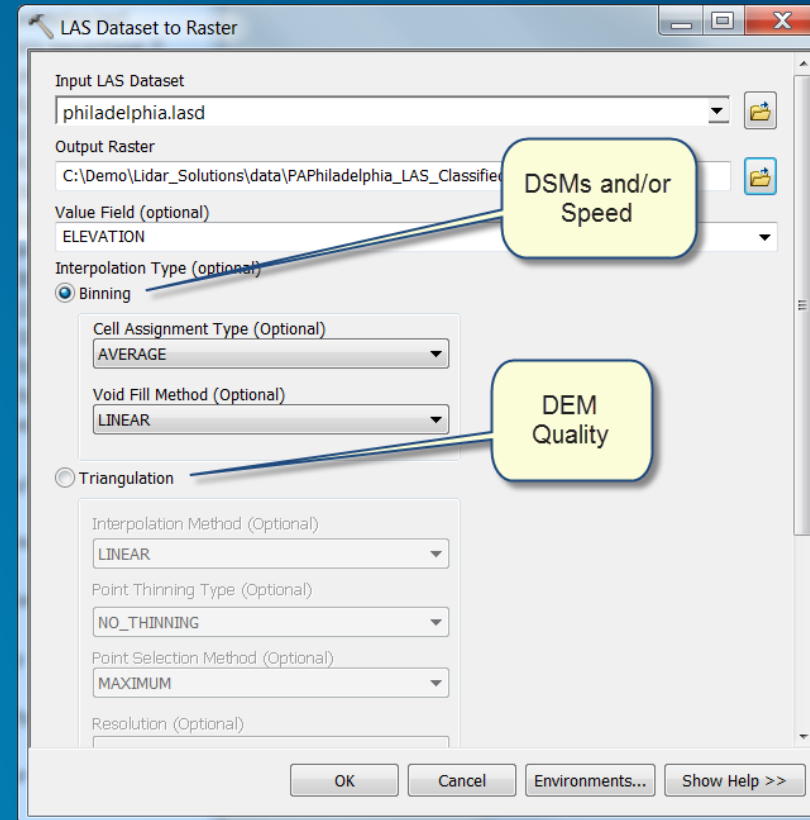
Digital Surface Model



Includes ground, trees, and buildings made using first returns.

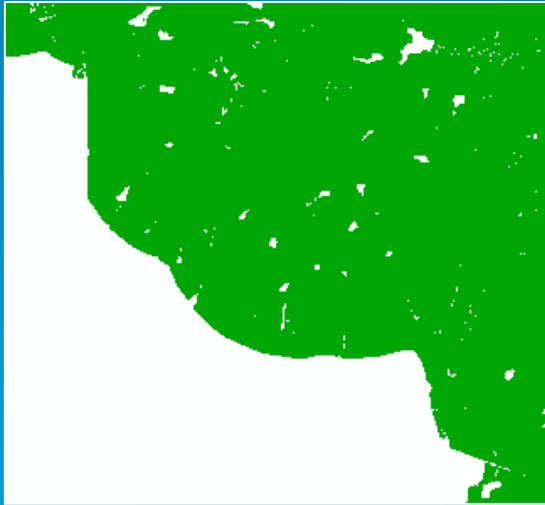
# LAS Dataset To Raster

- **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

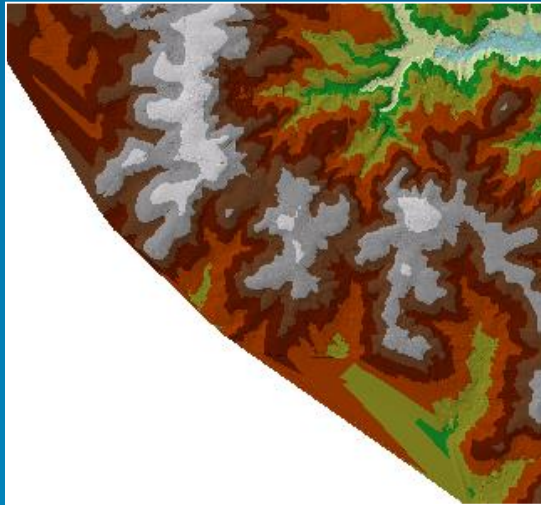




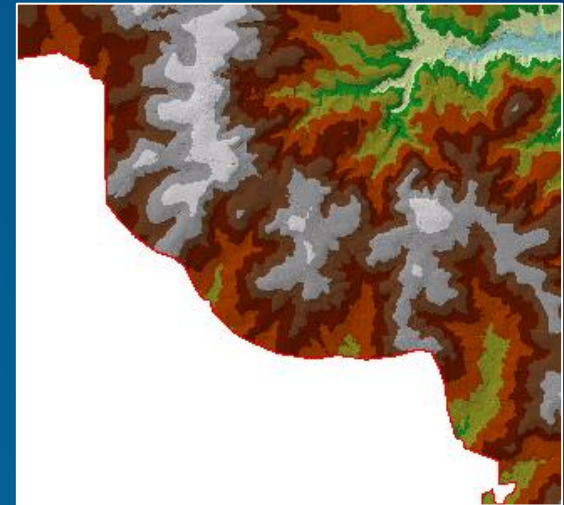
## Data Area Delineation



Dense collection of  
source measurement  
points (green)

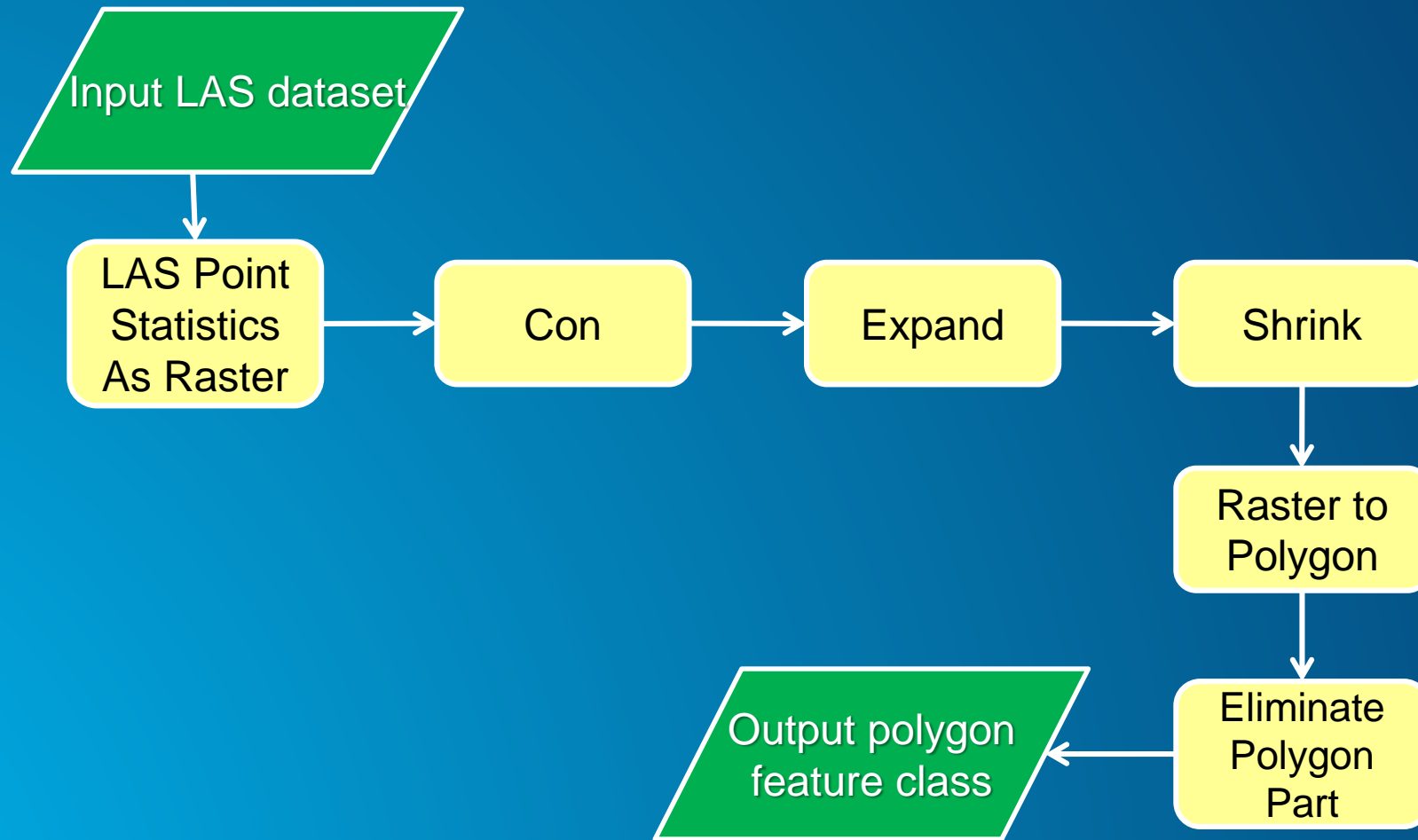


Triangulation of those  
points without a  
boundary constraint



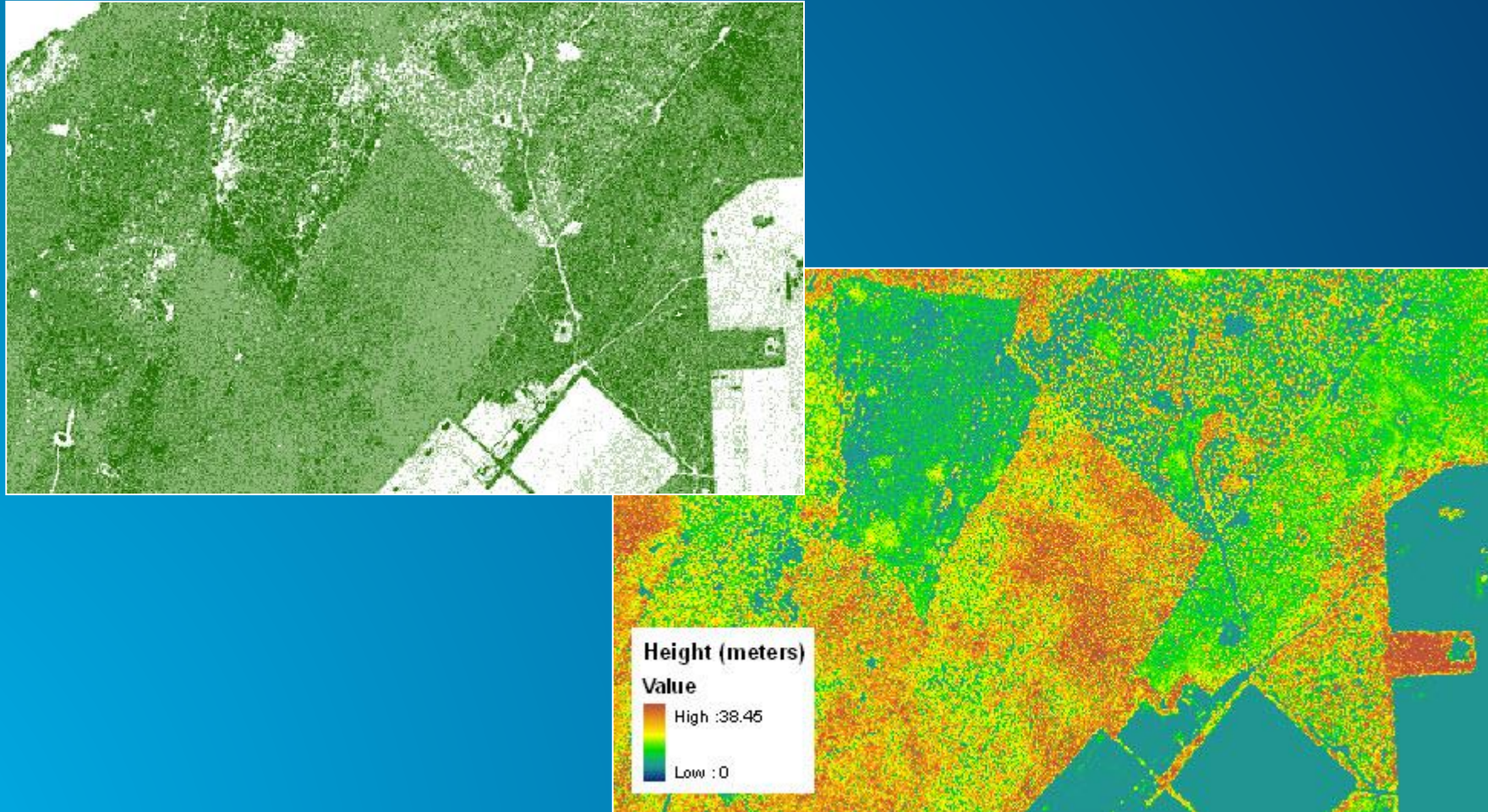
Constraint applied

# Workflow to Calculate a Data Area Polygon



**Demo**

# Estimating Forest Canopy Density and Height

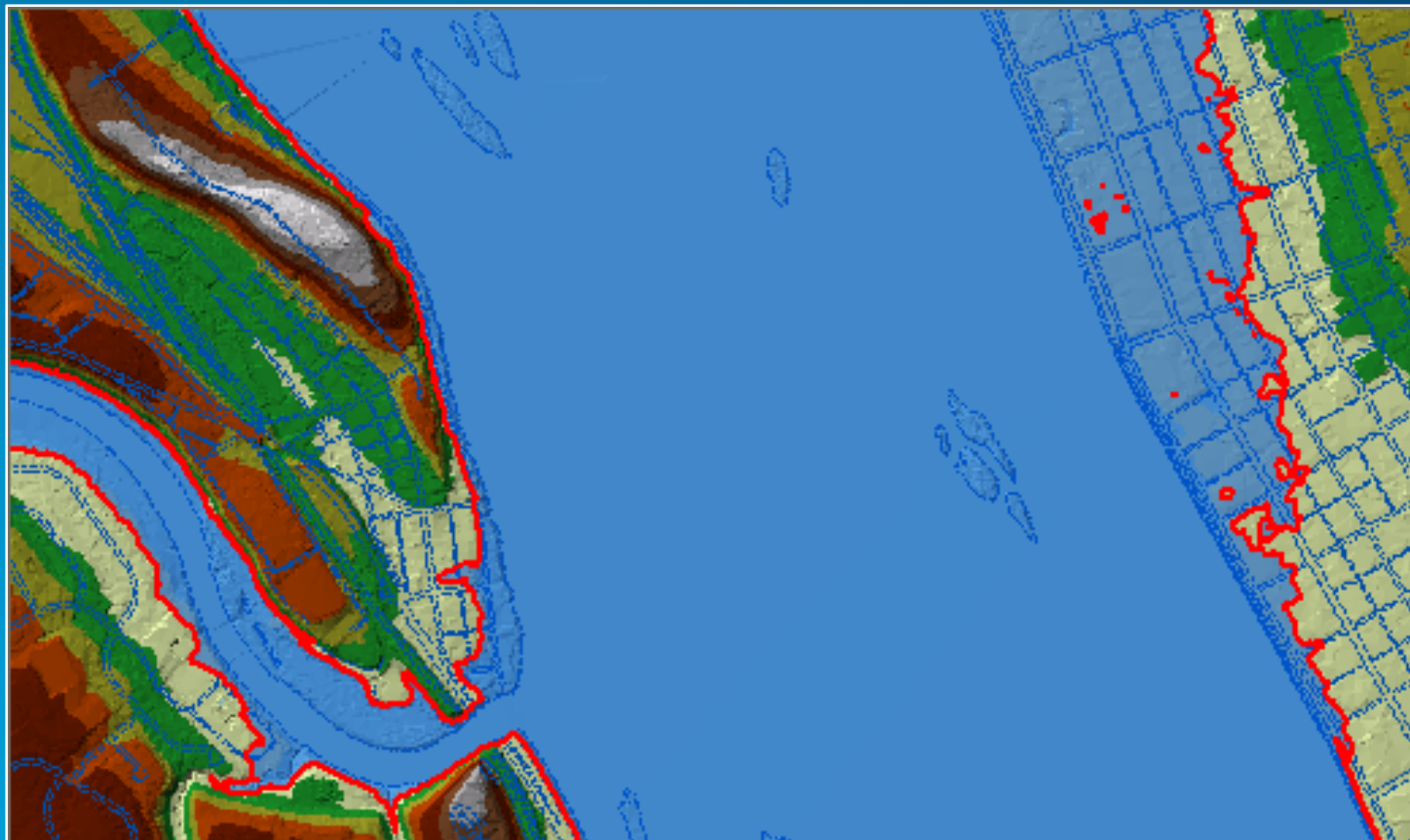




# Canopy Density and Height

- **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.**

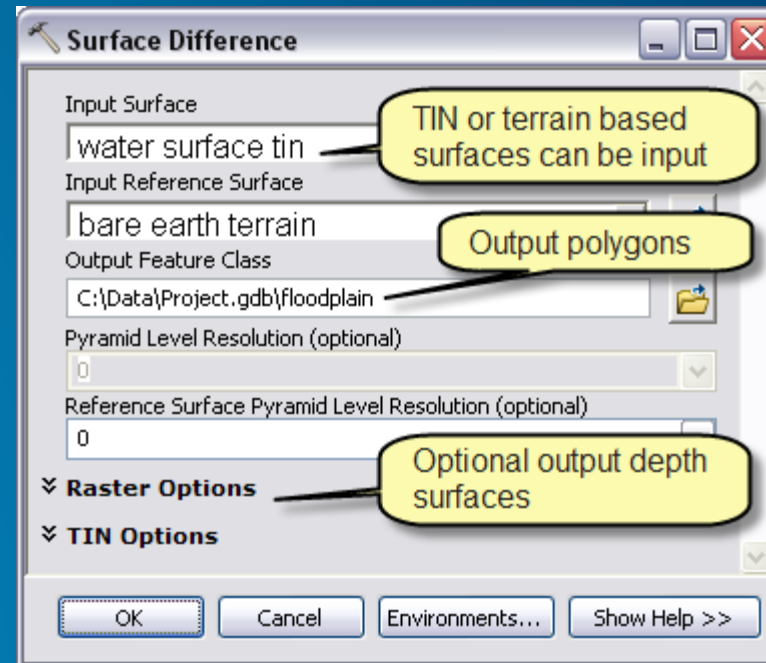
# Floodplain Delineation





# 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**

# Roof-Form Extraction for Procedural Building Modeling

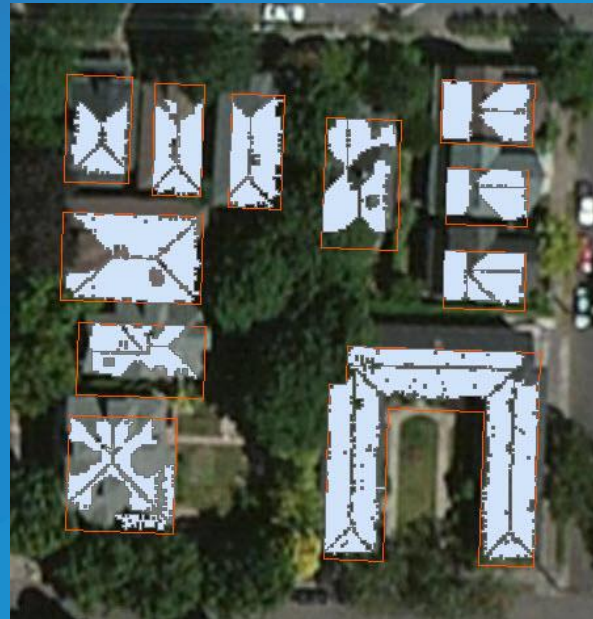
- Extract information about roof shape and height from lidar-derived surfaces
- Symbolize buildings in 3D using procedural rules
- Review output against LAS dataset



# Automated Roof-Form Attribute Extraction



- Classify areas of like slope & aspect in DSM



- Create roof-plane polygons

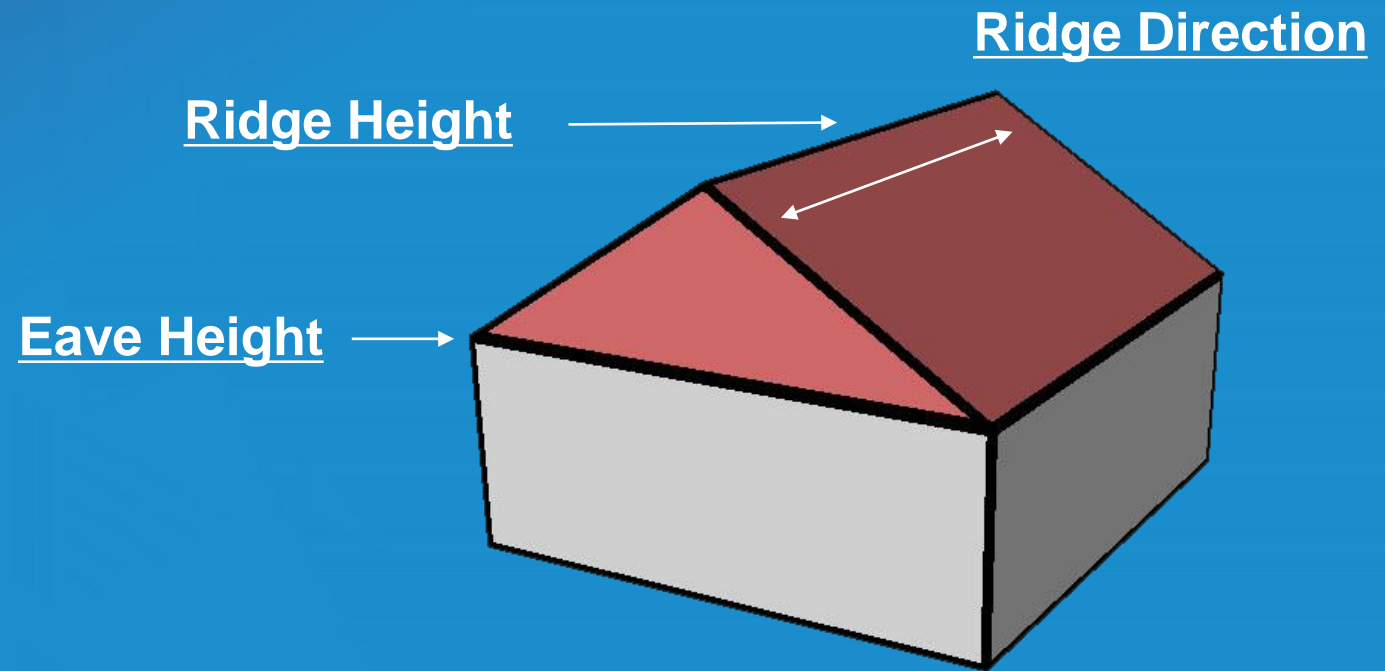


- Extract attributes

# Procedural Modeling



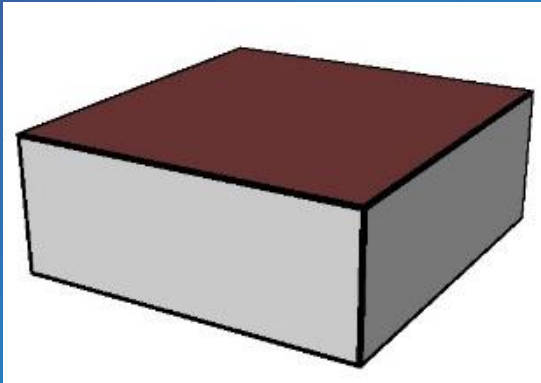
- Ridge Height = Highest point
- Eave Height = Lowest point
- Ridge Direction = Perpendicular to roof slope
- Roof form = Dependent on plane types found in footprint



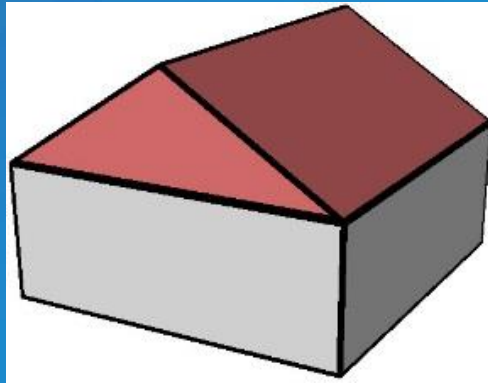
Roof Form: Gable

# Procedural Modeling

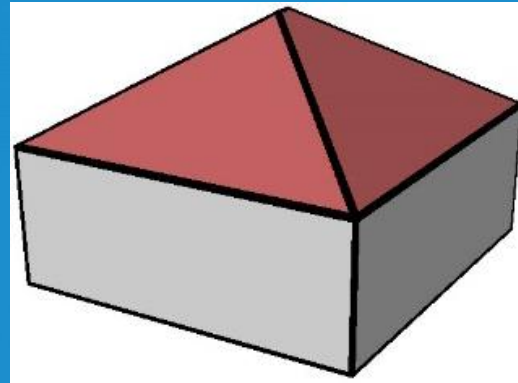
- Roof types automatically classified



Flat



Gable



Hip

- Other types supported:
  - Shed
  - Dome
  - Vault
  - Mansard



# Reviewing Output

- Compare procedural symbols directly against lidar
  - Manual changes update on-the-fly



**Demo**

# Do It Yourself!

- **‘Schematic City’ workflow in ArcGIS for Local Government Solutions**
  - Task-based workflow for ArcGIS Pro
  - Includes other workflows for 3D tree creation, and 3D city analysis
- **ArcGIS for 3D Cities: An Introduction**
  - Wednesday and Thursday 1:30 - 2:45
- **<http://solutions.arcgis.com/local-government/help/local-government-scenes/>**

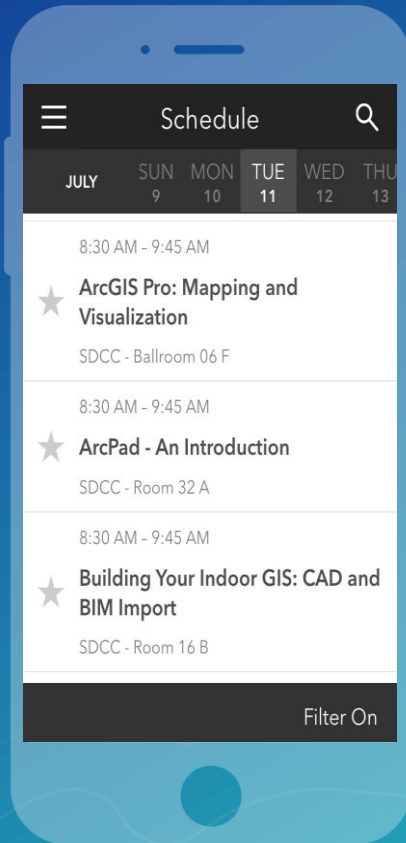
**Questions?**

# Please Take Our Survey on the Esri Events App!

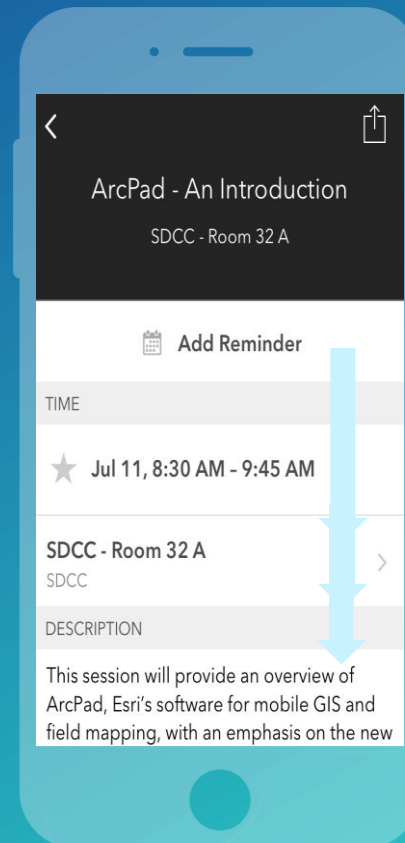
**Download the Esri Events app and find your event**



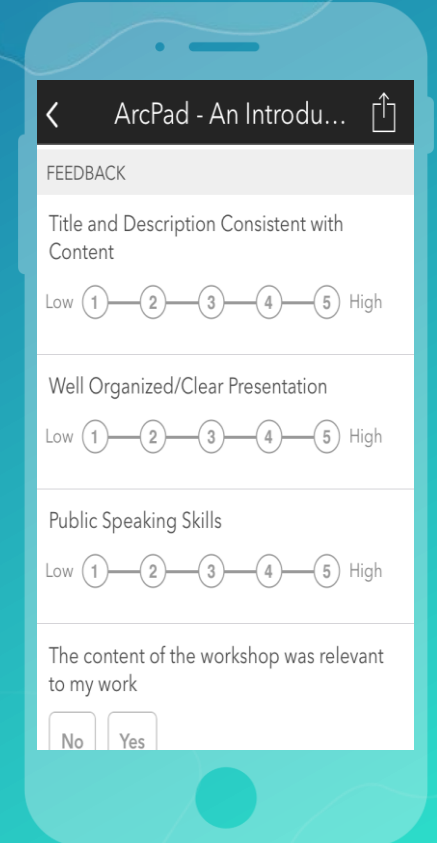
**Select the session you attended**



**Scroll down to find the survey**



**Complete Answers and Select "Submit"**







esri

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SCIENCE  
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WHERE