



Overview of 3D Analysis

Jinwu Ma

Khalid Duri

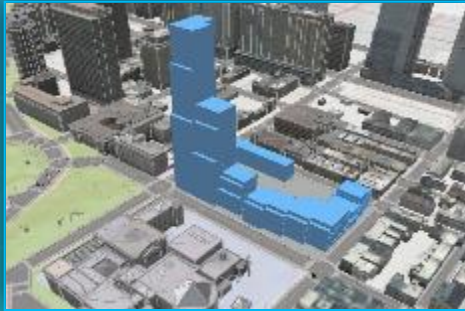
Jie Chang

Outline

- Overview of 3D GIS & Analysis
- 3D Data Basics
- Surface Creation & Analysis
- Lidar Visualization in Pro
- Lidar Classification
- Data Management & Conversion
- 3D Operators
- Conclusion | Q & A

Why use 3D GIS?

... because our world is 3D!



Improve understanding
3D visualization is intuitive



Solve 3D problems
Many spatial questions can only be answered in 3D space



Better communication
3D makes it easier to articulate ideas

3D GIS Features...



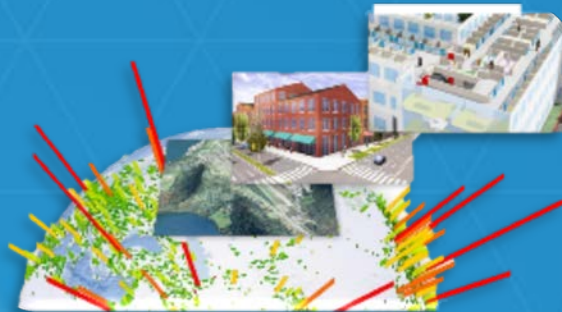
ArcGIS for 3D Cities



Share 3D scenes



3D Geodesign



Multiscale 3D Models



Lidar support



3D Analysis

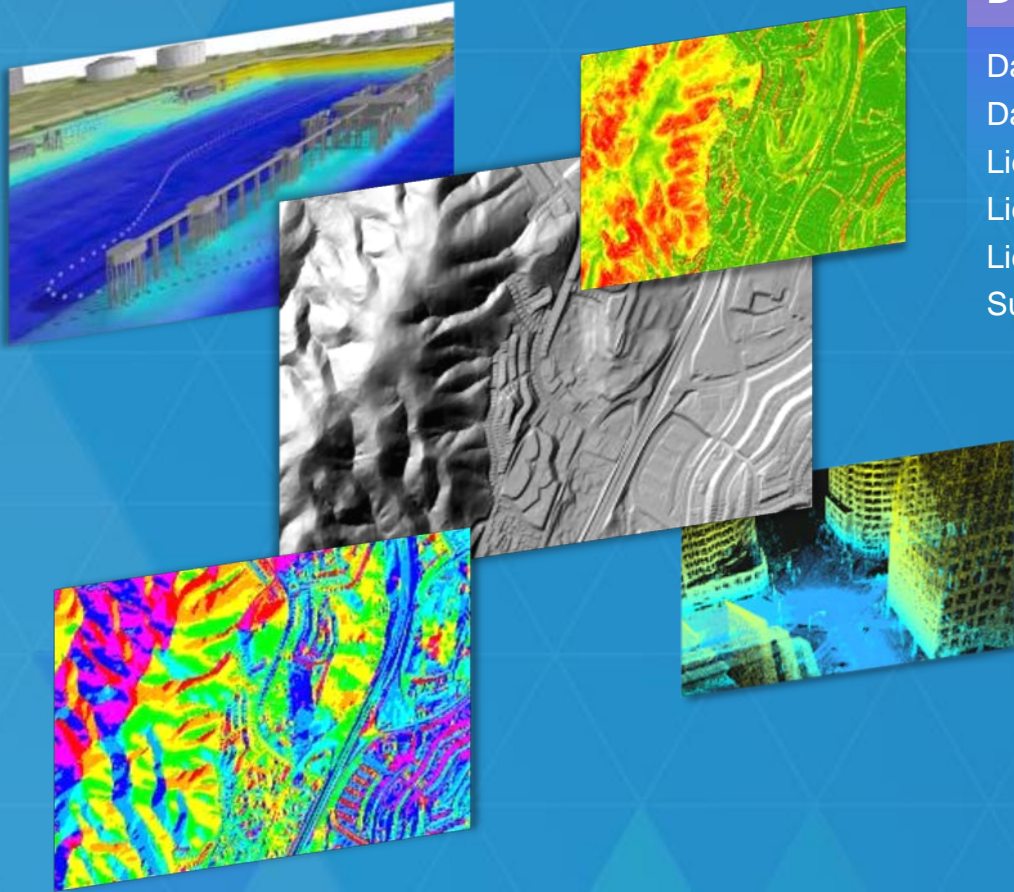


Integrated 3D



Surface modeling

3D Analyst Features...



Area & Volume

- Detect Change
- Determine Cut/Fill
- Calculate Surface Area & Volume

Data Management

- Data Creation
- Data Conversion
- Lidar QA/QC
- Lidar Classification
- Lidar Management
- Surface Interpolation

Surface Derivatives

- Contours
- Slope
- Aspect
- Statistics
- Identify Outliers
- Interpolate Geometry
- Perform Math Operations
- Building Footprint Regularization

Overlay

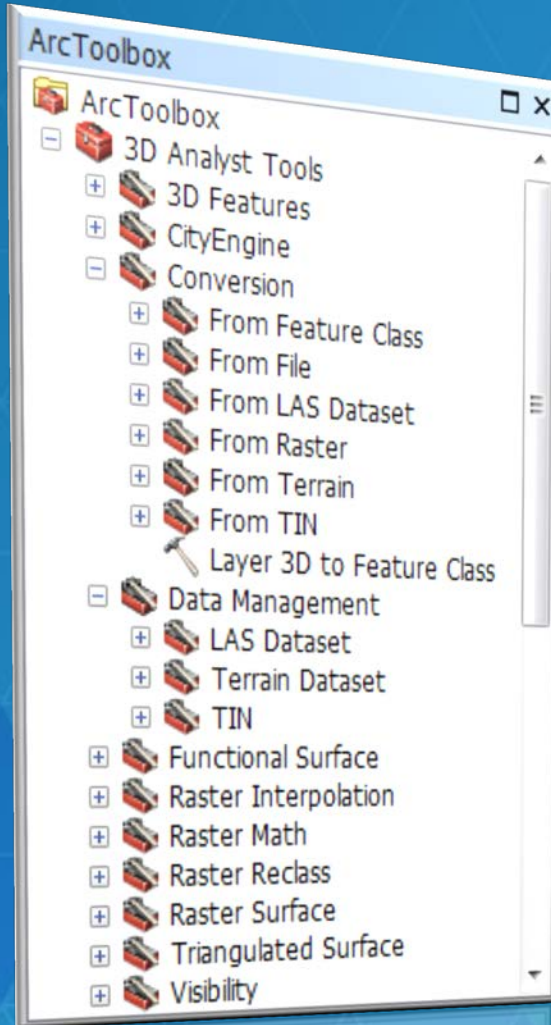
- 3D Statistics
- 3D Proximity
- 3D Intersections
- Visualization
- Profile Graphs
- Interpolate Features
- Extrude Between Surfaces

Visibility

- Sight Line Analysis
- Viewshed Determination
- Skyline Analysis
- Shadow Modeling
- Hillshade

Geoprocessing Tools

Framework for Analyzing & Managing Data

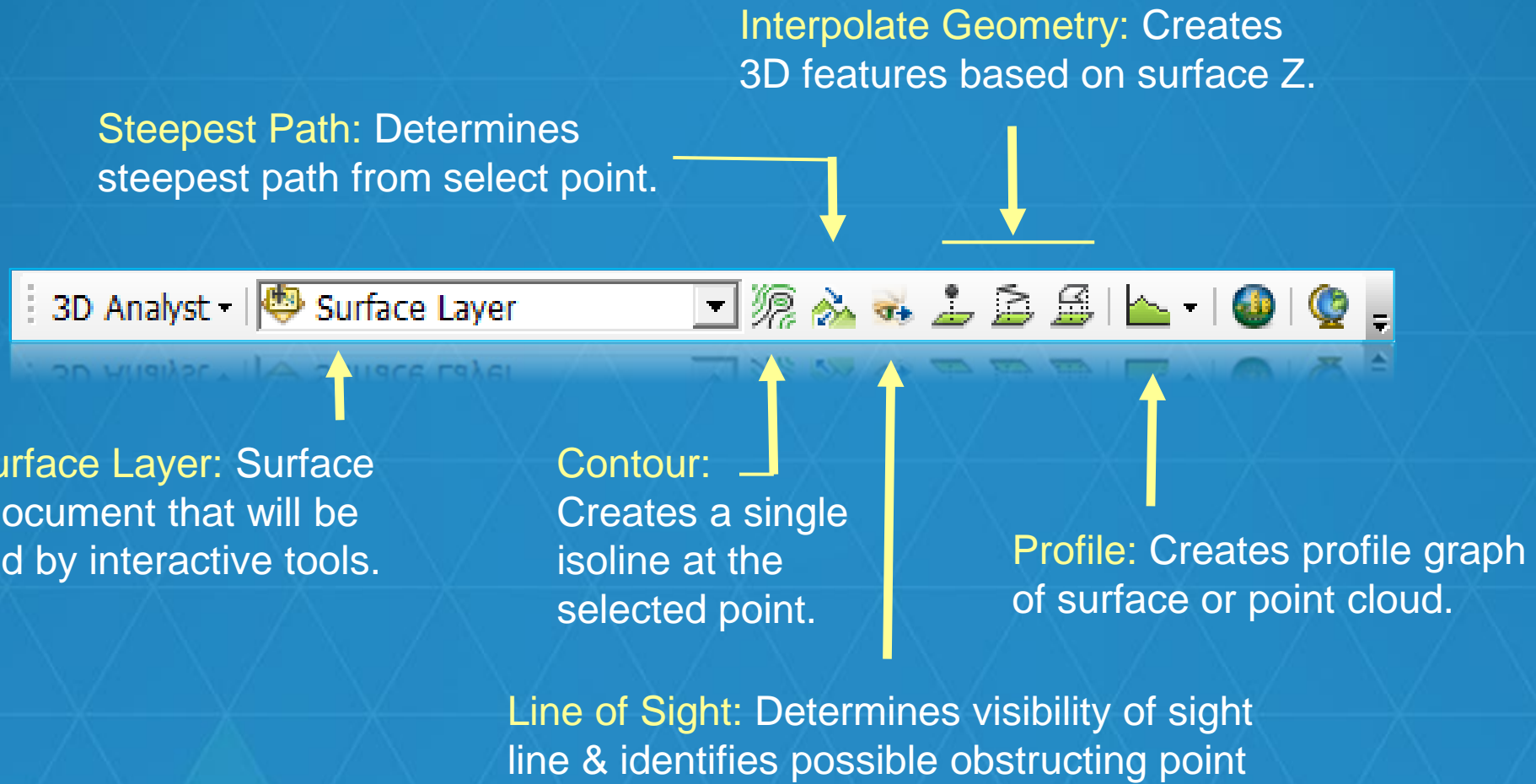


- **3D Features:** Overlay, proximity, and geometric analysis of 3D features.
- **Data Management:** Lidar classification & analysis, TIN & terrain management.
- **Data Conversion:** Robust interoperability.
- **Functional Surface:** Surface analysis.
- **Raster toolsets:** Interpolation, mathematic operations, reclassification & surface derivatives.
- **Triangulated Surface:** TIN based analysis.
- **Visibility:** Sightline, viewshed, & skyline analysis.

Recommended Session: ModelBuilder – Getting Started, Wed 10:00 Exhibit Hall A

Exploratory Analysis

Interactive Tools in ArcMap



Representing XYZ

Understanding the Data Types

How is XYZ Information Represented?

3D Features

Points

Lines

Polygons

Multipatch

LAS Dataset

NetCDF



Surface

Raster

TIN

Terrain

LAS Dataset

NetCDF

Understanding the Surface

Any continuous measurement with one value for a given x-y location $z = f(x,y)$



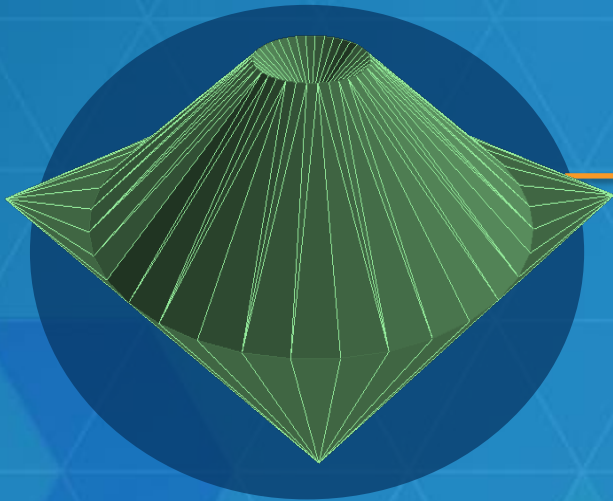
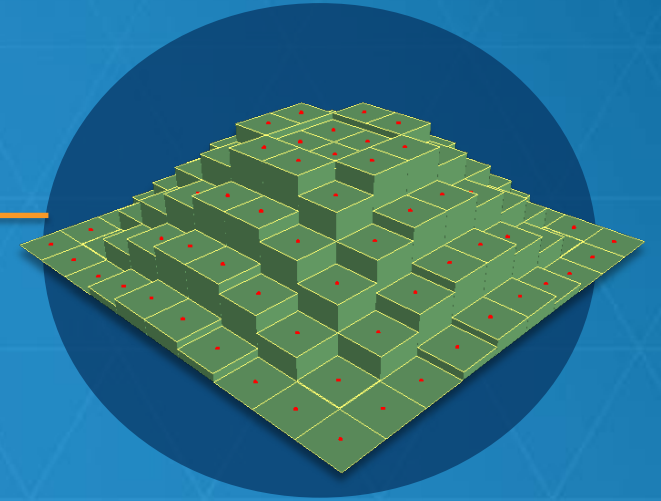
- Temperature
- Gravity
- Soil studies
- Epidemiology
- Chemical concentrations
- Many diverse applications...

More than just topography!

Surface Data Types

Raster Surface

- Made by interpolation, generalize source measurements to cell size
- Fast to process, support robust math operations



TIN Based Surfaces

- Created by triangulation, maintain source measurements
- Support robust surface definitions & data

Triangulated Irregular Network (TIN) Based Surfaces

TIN

Well-suited for engineering applications and analysis of study areas that are not exceedingly large, provides interactive editing options.



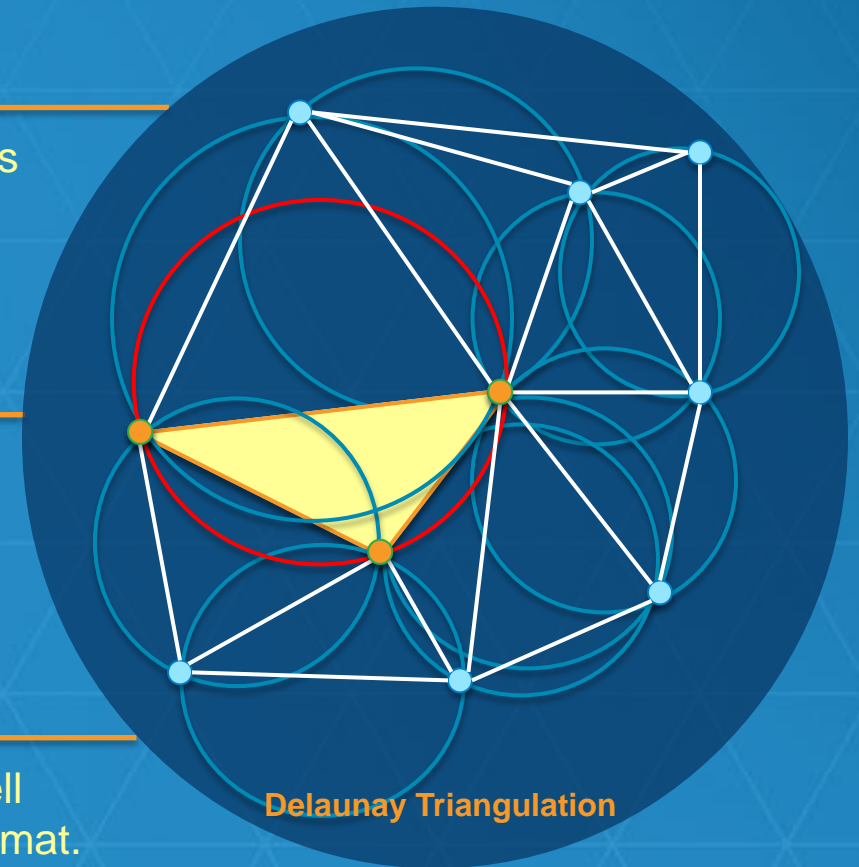
Terrain

Multi-resolution, scalable, offers robust support for handling large amounts of data.



LAS Dataset

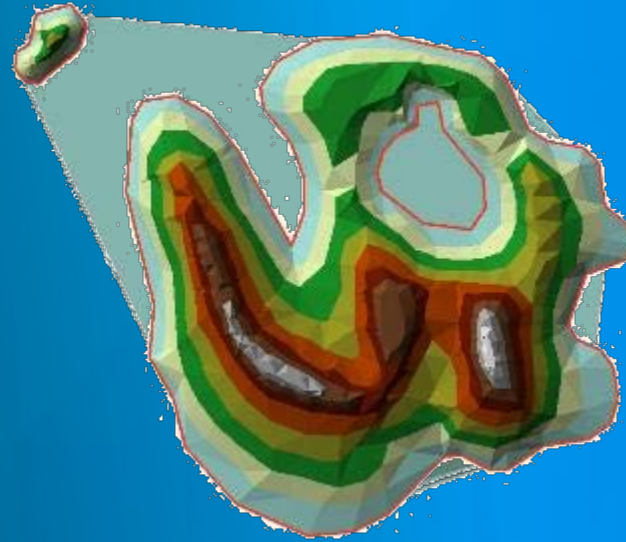
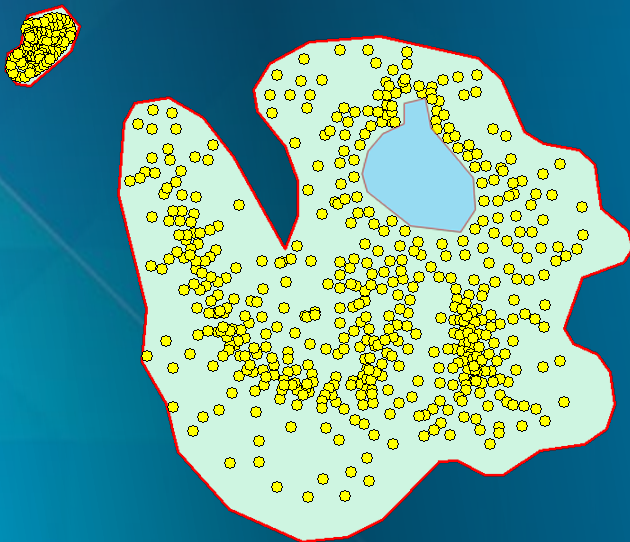
Rapidly visualize, filter, perform QA/QC and analyze lidar data. Well suited for aerial collections, supports compressed lidar in ZLAS format.



Surface Feature Types

TIN Based Surface Concepts

- **Mass points:** Measurements used for triangulation
- **Erase polygon:** Interior areas of no data
- **Replace polygon:** Assigns a constant z value
- **Clip polygon:** Defines the interpolation zone



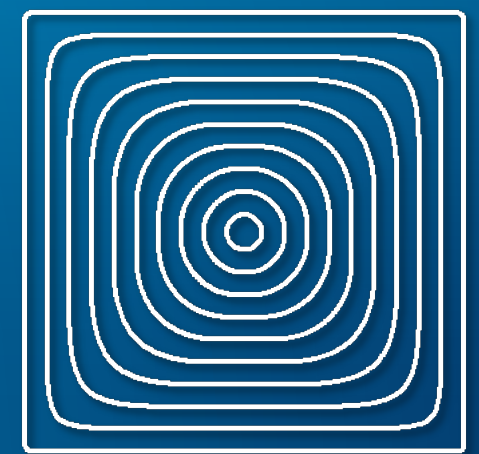
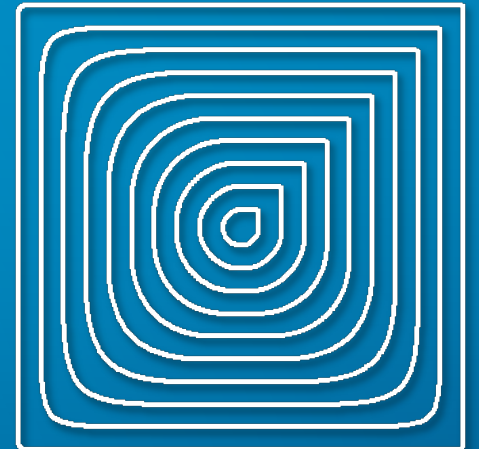
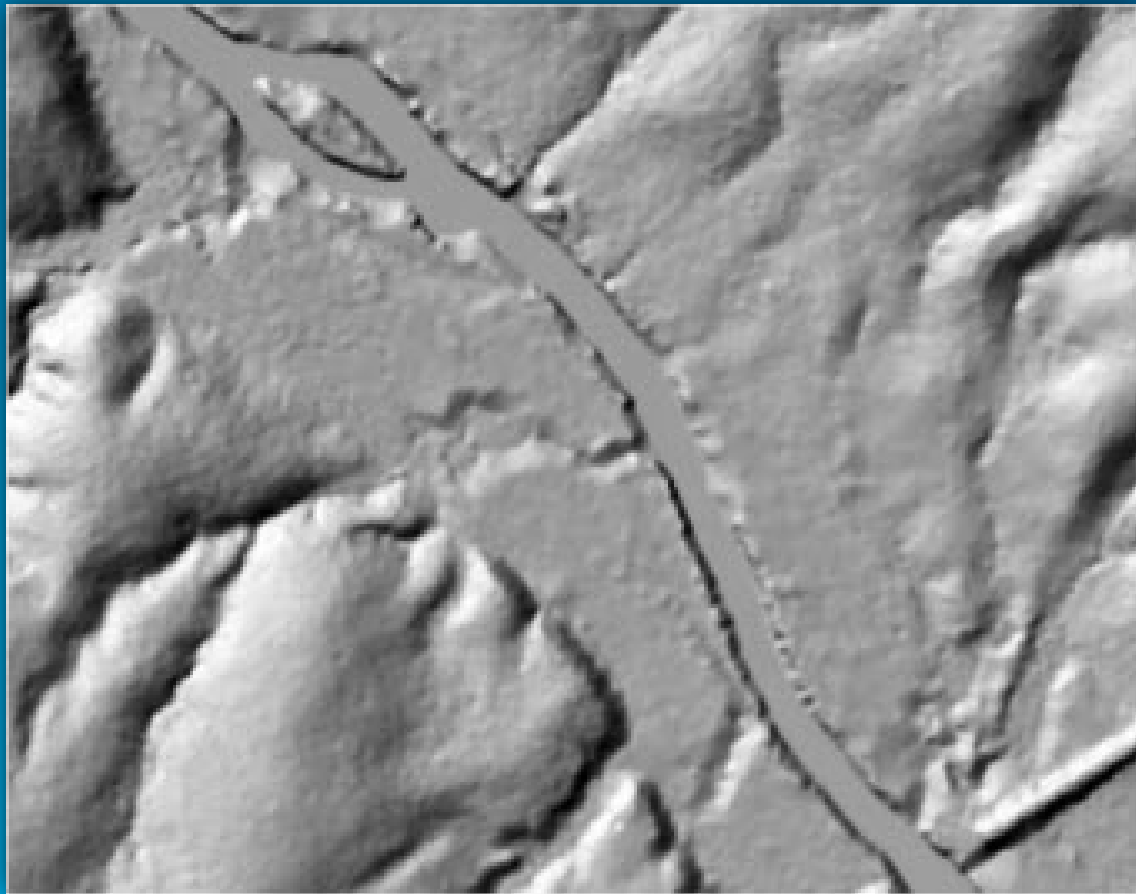
Also supports:

- Break lines
- Tag values

Note: Tag values are only supported by the TIN dataset.

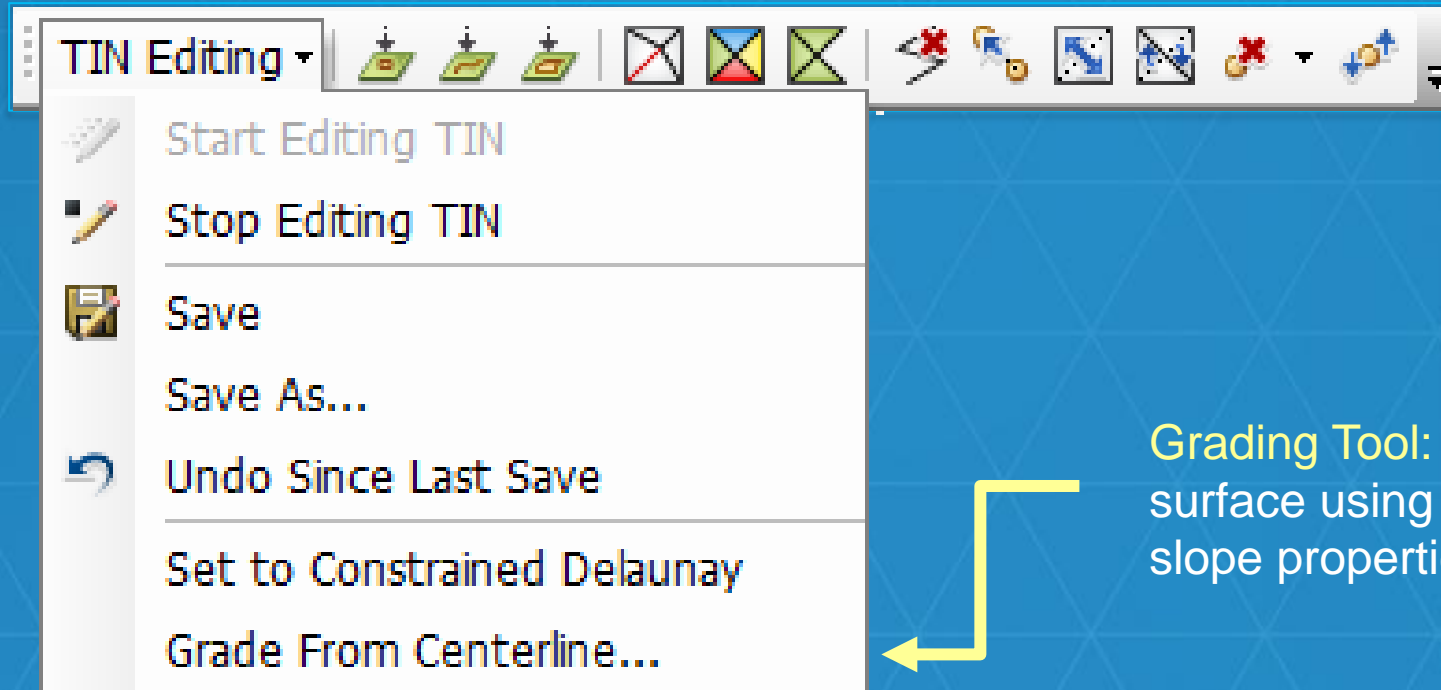
Breaklines & Hard/Soft Designation

TIN Based Surface Concepts



Editing a TIN Surface in ArcMap

TIN Editors: Add, modify, or remove nodes, edges, triangles & tag values



Grading Tool: Modify surface using line with slope properties.

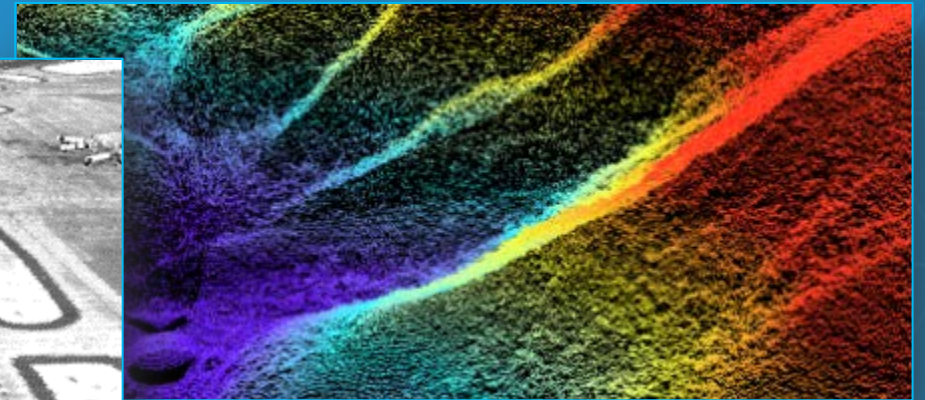


Surface Creation & Analysis

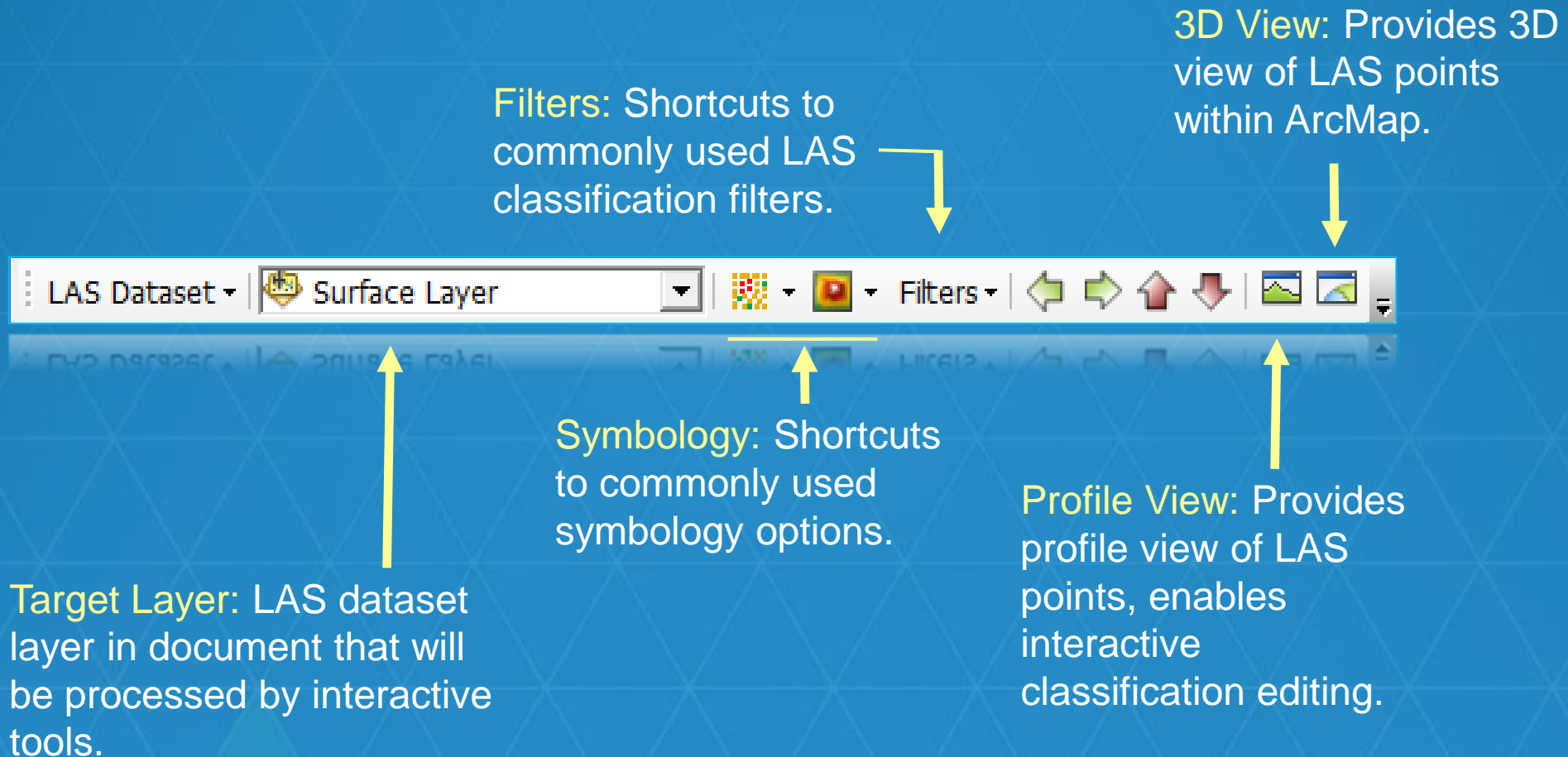
Jinwu Ma

What's New for Lidar in ArcGIS Pro

- Enhanced lidar rendering
- Support for ZLAS & LAS file version 1.4
- **Extract LAS:** New tool for projecting, filtering, clipping and rearranging LAS points
- **Create LAS Dataset:** Supports the creation of PRJ overrides for spatial reference



Interacting with Lidar in ArcMap

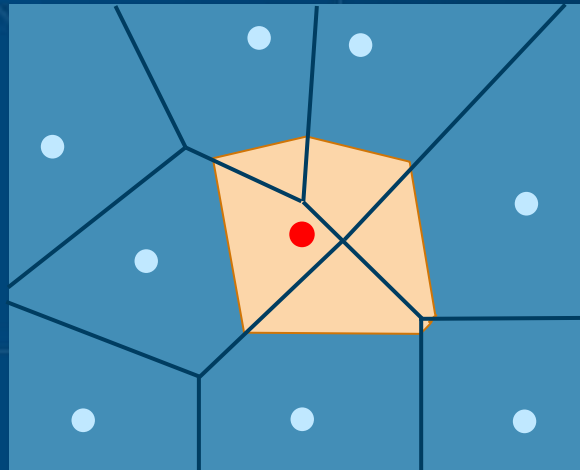
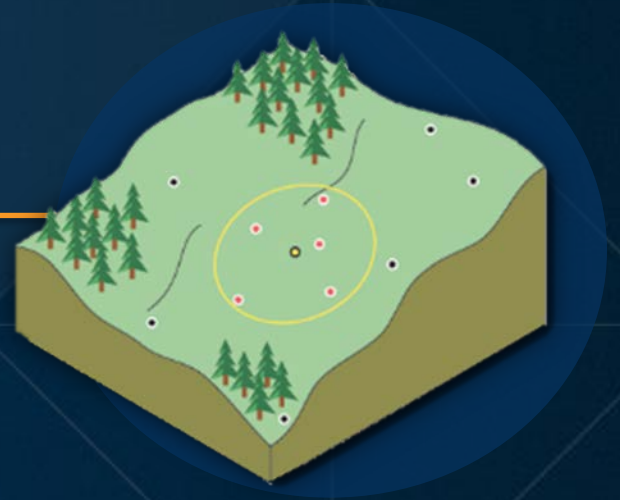


Raster Interpolation

Distance Based Weight Interpolators

Inverse Distance Weighted (IDW)

Consider using when source data measurements are dense enough to capture the local surface variation required for analysis, and interpolation barrier enforcement is needed.



Natural Neighbor

A better version of IDW, but takes longer to process due to its “smarter” method of applying weights. Consider using if you do not want your surface to exceed the min/max values in the sample measurements.

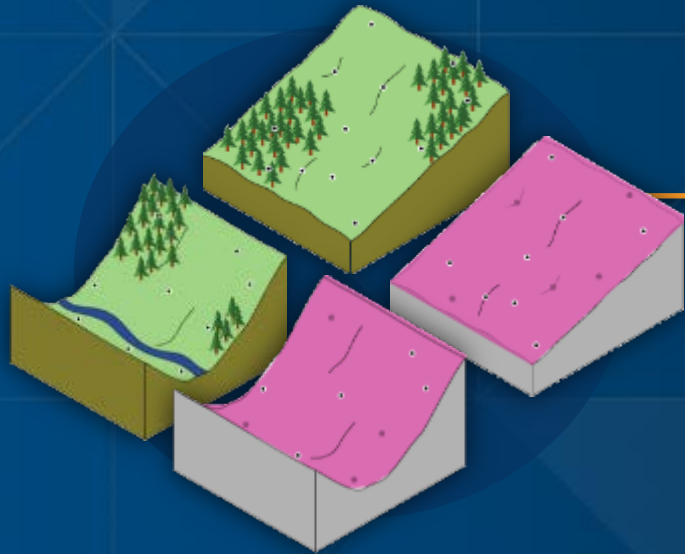
Recommended Sessions: *Creating Surfaces from Various Data Sources Tue 10:15 – 11:30 Room 17B*
Surface Interpolation Wed 4:30 – 5:15 Demo Theater 13

Raster Interpolation

Trend Interpolators

Spline

Consider when needing to capture sinks and peaks that are not part of sparsely sampled measurements.



Trend

Use when looking for trends in source measurements that represents data with gradual variation (e.g. wind speed, temperature)

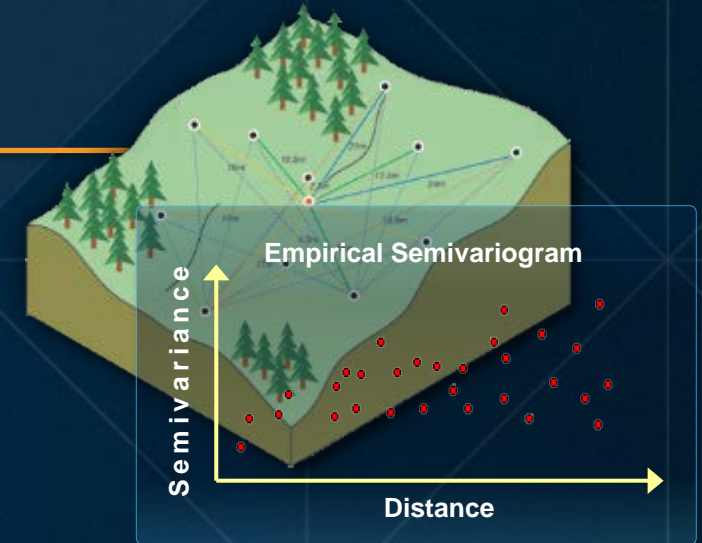
Recommended Sessions: *Creating Surfaces from Various Data Sources Tue 10:15 – 11:30 Room 17B*
Surface Interpolation Wed 4:30 – 5:15 Demo Theater 13

Raster Interpolation

Deterministic & Hydrologic Surface Interpolators

Kriging

Widely used when working with sparse measurements if trends in data are well understood. Consider Kriging with Geostatistical Analyst.



Topo To Raster

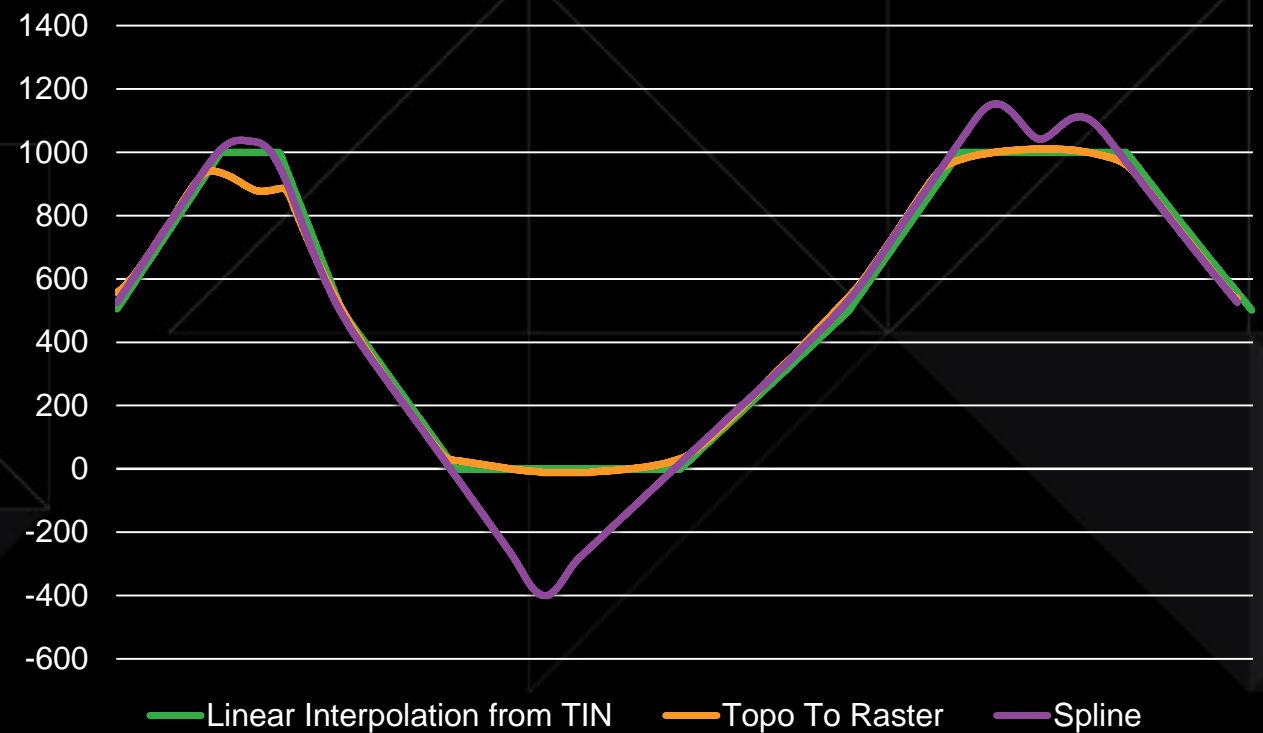


Generates hydrologically correct surface that connects drainage structures, eliminates localized sinks, and captures ridges & streams.

Recommended Sessions: Intro to Geostatistical Analyst Wed 1:30 – 2:45 Room 5A
Empirical Bayesian Kriging Tue 3:30 – 4:15 Demo Theater 13

Choosing the Most Appropriate Surface Model

- What is the nature of data being modeled?
- How is the data distributed?
- How will the data be used?



What's New for Feature Analysis in ArcGIS Pro 1.1

- **Layer 3D To Feature Class:** New to Pro with enhanced 3D layer exporting
- **Minimum Bounding Volume:** Find the minimum bounding volume of a collection of 3D features
- **Regularize Building Footprint:** Eliminate the distortions of unwanted artifacts in footprints extracted from a surface

3D Set Operators

Geometric Operations with Multipatch Features

- Intersect 3D
- Union 3D

- Difference 3D
- Inside 3D

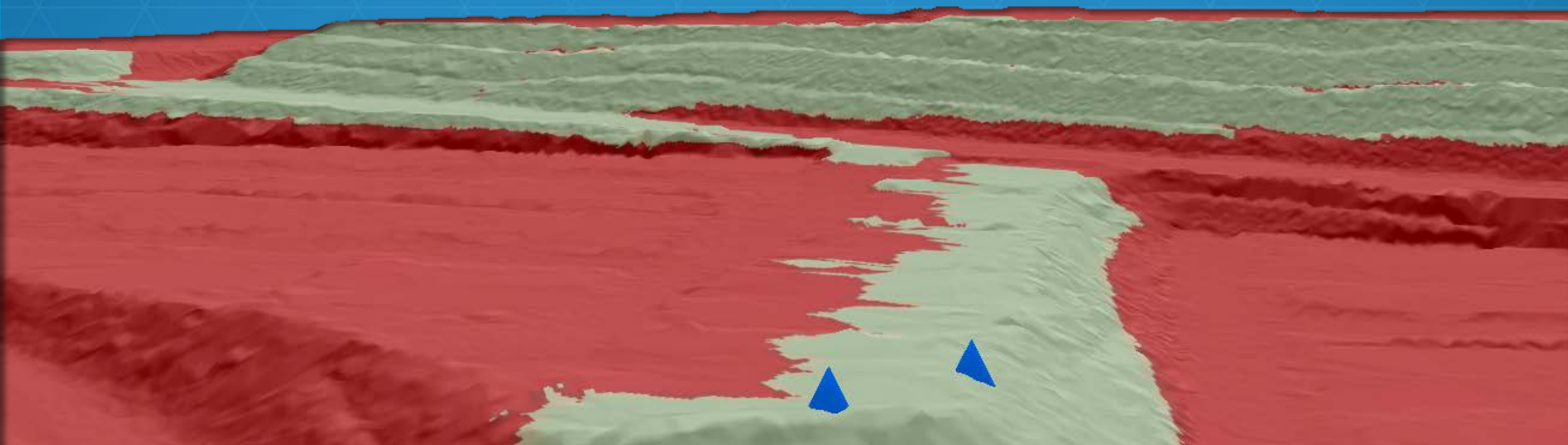
- Intersect 3D
- Union 3D



Viewshed Analysis

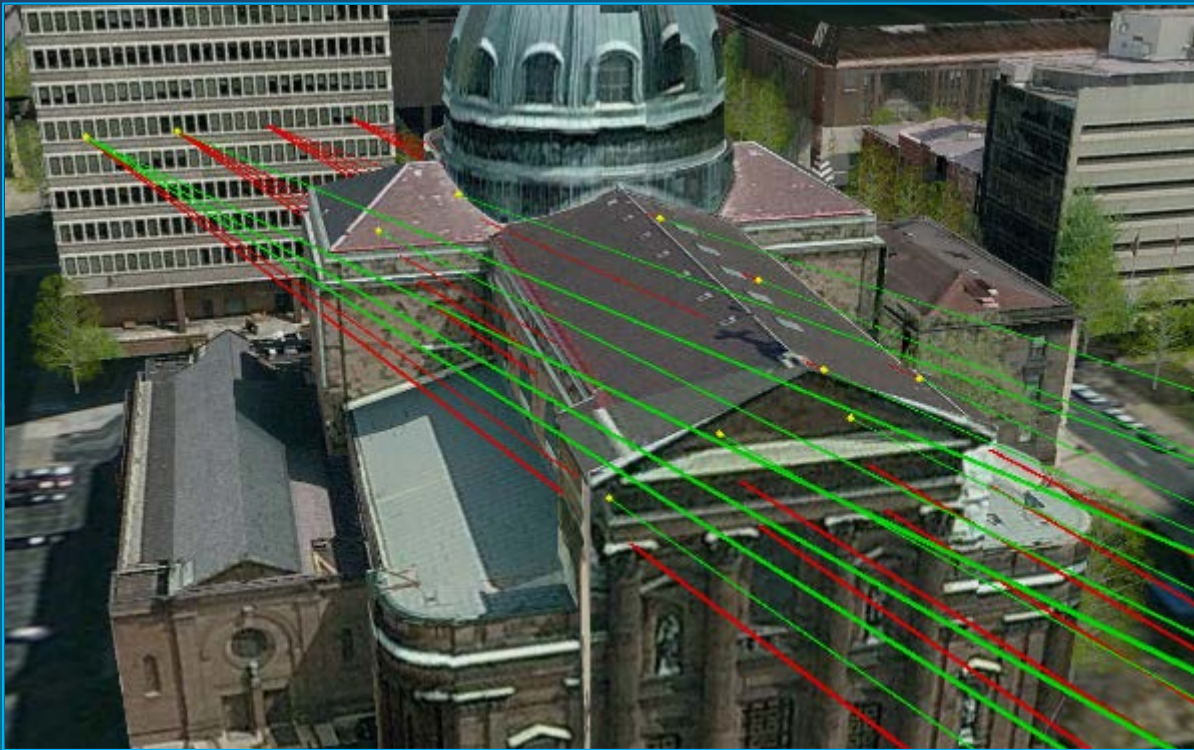
Raster Surface Visibility

- Determine how many observers can see a given location
- Determine which observers see a specific location
- Find the height a non-visible location must be raised to become visible



Line of Sight

Visibility Along 2-Point Sightlines

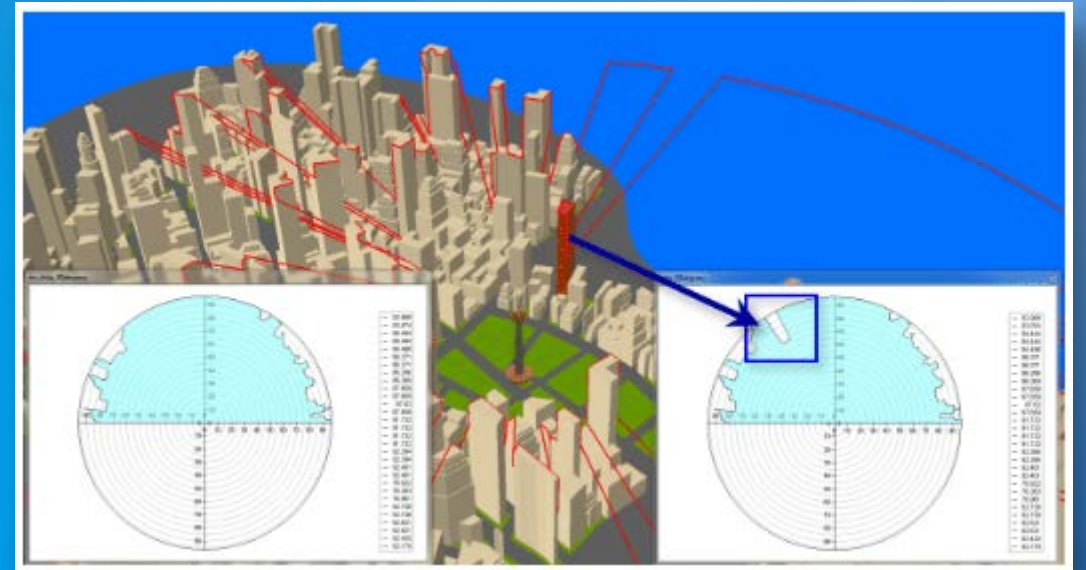


- Determine visibility along a line
- Identify the obstructions preventing the end point's visibility
- Use Construct Sight Lines to generate 2-point lines between observer points and target features

Skyline Analysis

Studying the Horizon

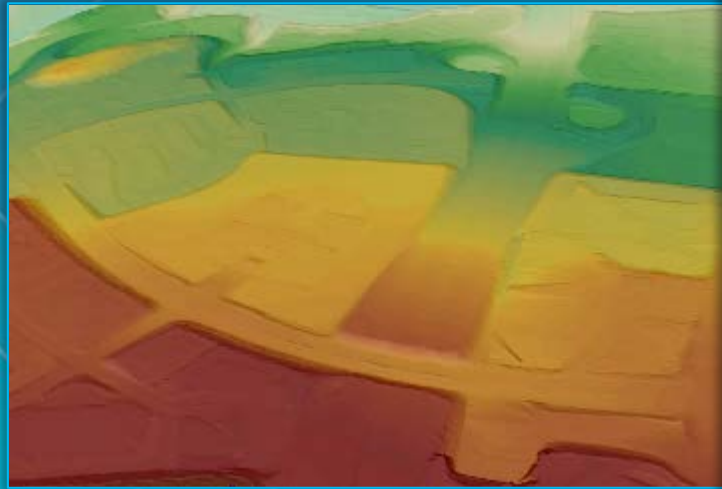
- Delineate the horizon for each observer
- Segment the horizon by each contributing feature
- Graph the percent of possible sky that is obstructed by observers



Shadow Modelling

Shadows from the Sun and Localized Light Sources

- Shadows cast by sunlight for a given date/time
- Find the shadows cast by localized light sources



Hillshade at 45°



Hillshade at 90°

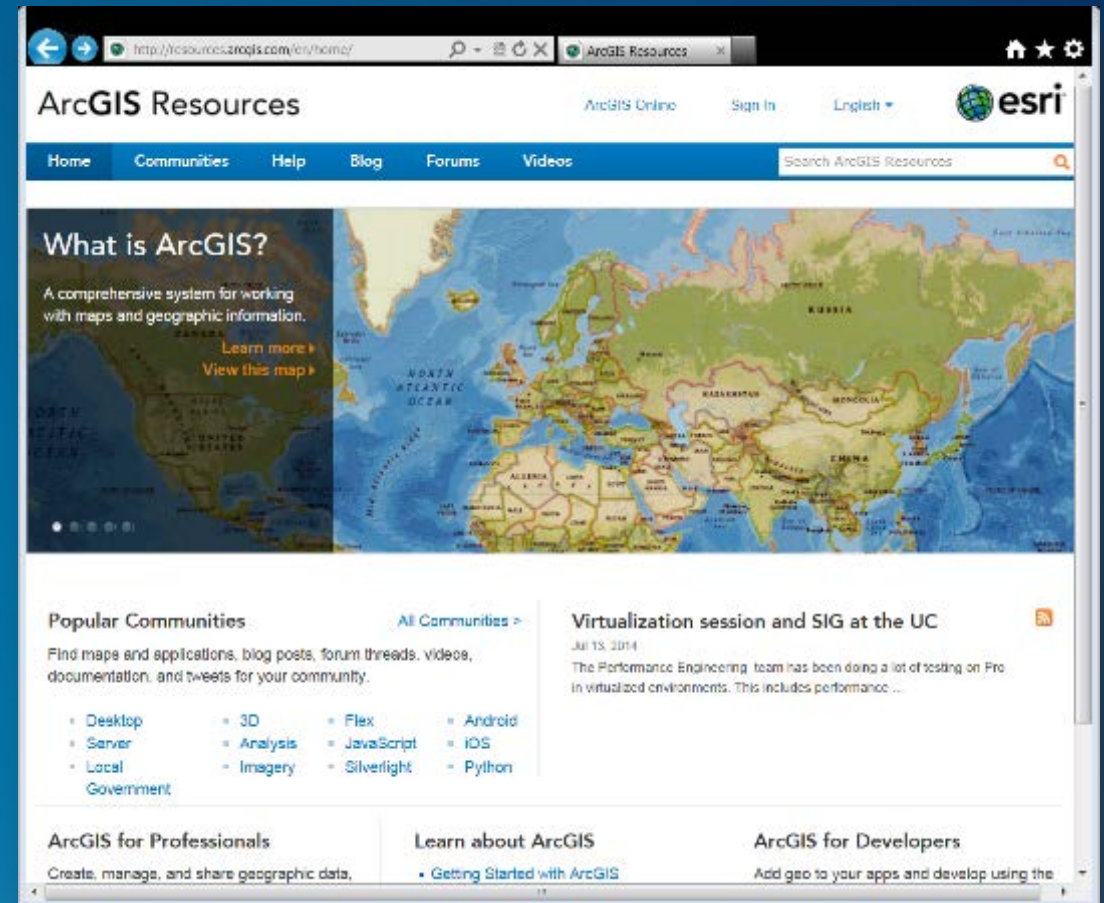


Sun Shadow Volume

3D Community on ArcGIS Resource Center

<http://resources.arcgis.com>

- **Helpful Utilities:** Many custom tools and useful applications
- **Solution Templates:** Guides and sample data to illustrate best practice applications for tasks in 3D
- **News:** Learn about what's new in 3D GIS.





At the UC

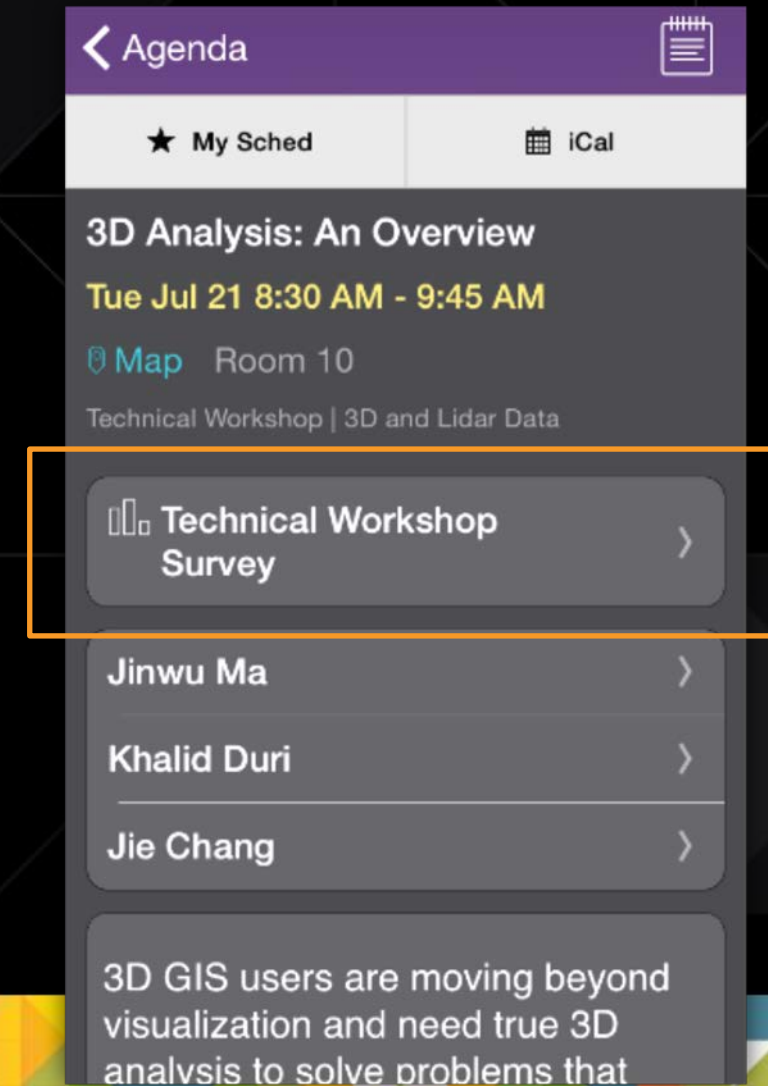
- Product Island
main conference hall
- Tech Support
follow up assistance

Online

- GeoNet
<http://geonet.esri.com/welcome>
- 3D GIS Resource Center
<http://resources.arcgis.com/communities/3d>
- ArcGIS Desktop Help
<http://help.arcgis.com>

Thank You!

Please fill out a session survey
in your mobile app by clicking
“Technical Workshop Survey”





Understanding our world.