3D Analyst: An Introduction

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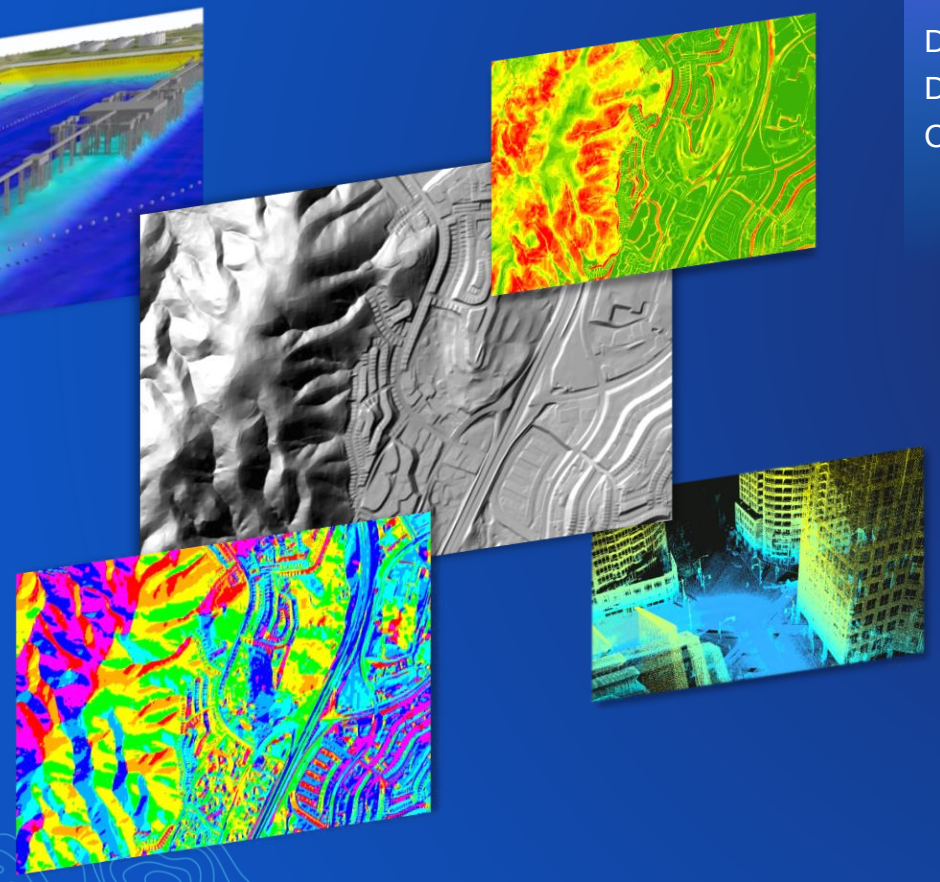
Workshop Outline

- What’s New
- 3D Data Types
- LAS & Surface Analysis
- 3D Feature Analysis
- Demos
- Q & A

What’s New

- Improved depth enhancement for LAS visualization
- Improved results & performance for Classify LAS Building
- Improved performance for Polygon Volume calculation
- Clip 3D line profile graph to visible extent
- Easily add multiple surfaces as separate elevation sources
- Generate a profile view to interactively examine a 3D cross section
- Interactively assess the cut-fill needed to level an elevation surface

3D Analyst



Area & Volume

Detect Change
Determine Cut/Fill
Calculate Surface Area & Volume

Visibility

Line of Sight
Viewshed
Skyline
Shadow Modeling

Data Management

Data Conversion
Lidar QA/QC
Lidar Classification
Surface Interpolation
Import/Export Data

Overlay

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

Surface Derivatives

Contours
Slope
Aspect
Hillshade
Statistics
Identify Outliers
Interpolate Geometry
Perform Math Operations

Overview of 3D Data Types

Surface Types & Vector Geometry

Storing XYZ Information

Vector Geometry

Points | Lines| Polygon

Point Cloud

Multipatch | Mesh

Surface Model

Triangulated Irregular Network

Raster

Understanding the 3D Mesh

- **Collection of triangles that define 3D shapes**
- **Support textures, colors, and transparency**
- **Can be used to represent many types of data:**
  - Discrete objects
    - Buildings
    - Vegetation
    - Machinery
  - Continuous measurements
    - Terrain
    - Volumetric shells

Multipatch Geometry

- **Native mesh geometry format for ArcGIS**
- **Supports textures & colors when stored in a geodatabase**
- **Supported as input for numerous automated analysis operations**
- **Single resolution dataset**
- **Created by:**
  - Editing in ArcGIS Pro
  - Deriving from surfaces
  - Importing from other 3D model formats
  - Symbolizing points, lines, and polygons with 3D properties

Constructing 3D Features

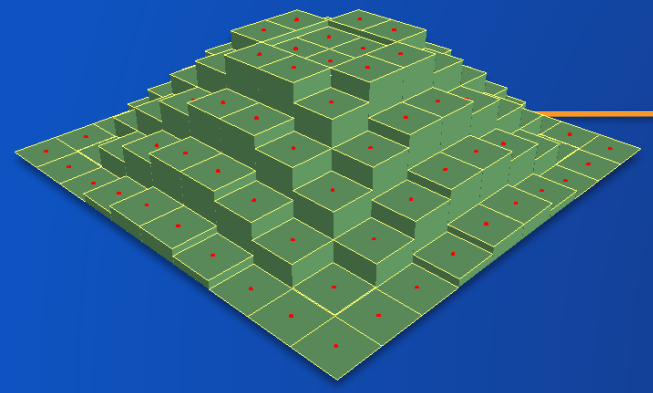
- Interactive digitization
- Symbolize points, lines and polygons:
  - Procedural rules to create buildings from polygons, trees from points, etc…
  - Extrusion/base height properties to create walls from lines, volumes from polygons, and cylinders from points
  - 3D marker symbols for points, tube symbols for lines
- Derive from spatial operations
- Import 3D models from a variety of data sources:
  - Collada
  - 3D Studio Max
  - OpenFlight
  - VRML/GeoVRML
  - Wavefront OBJ *(Pro only)*
  - SketchUp *(Desktop only)*

Understanding the Surface

Continuous data with one Z value for a given position in XY space.

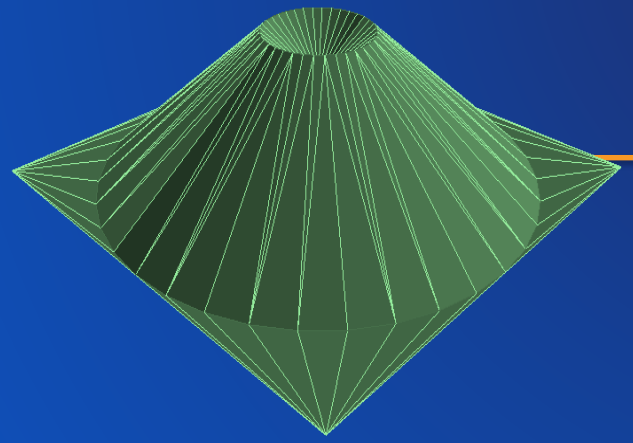
- **Temperature**
- **Gravitational fields**
- **Wind speeds**
- **Chemical concentrations**
- **Many diverse applications…**

Surface Data Models



Raster Surface

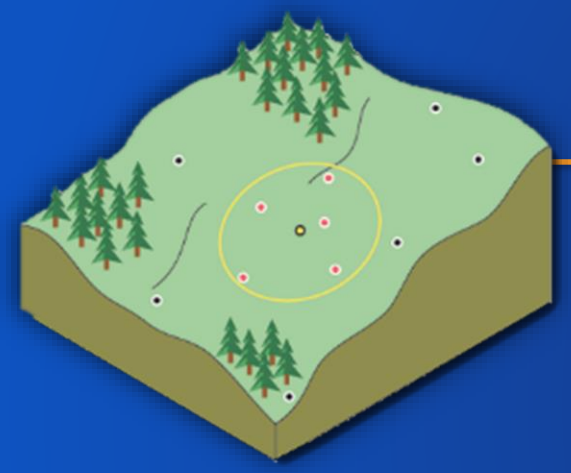
- Made by interpolation, generalize source measurements to cell size
- Fast to process, support robust math operations



TIN Based Surfaces

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

Distance Based Interpolation

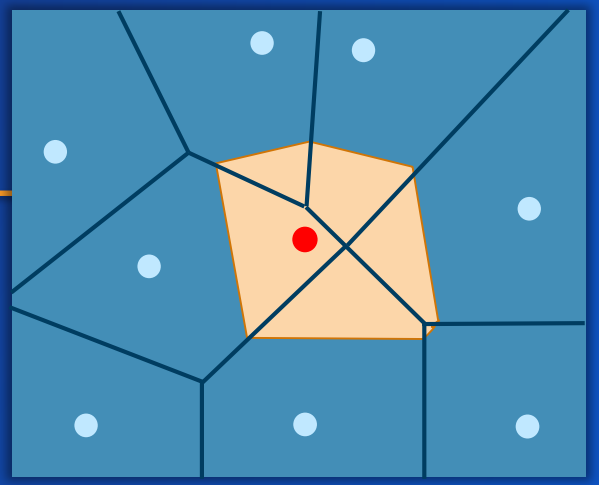


Inverse Distance Weighted (IDW)

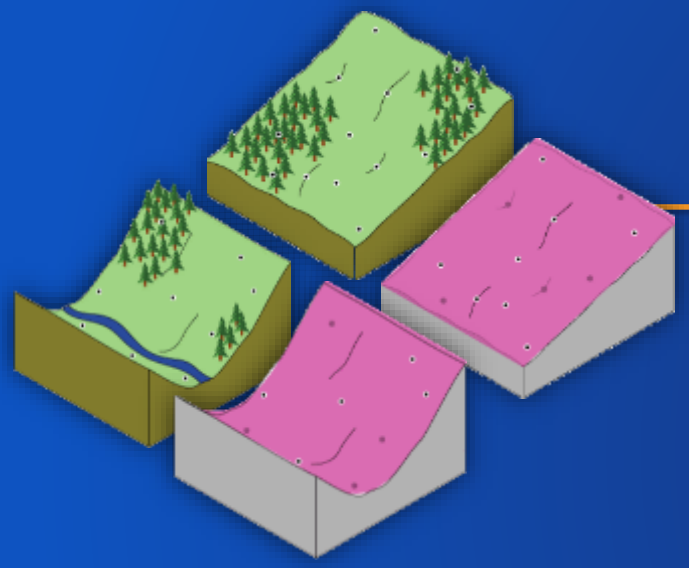
Consider using with evenly distributed source measurements that capture local surface variation.

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.



Trend Interpolators

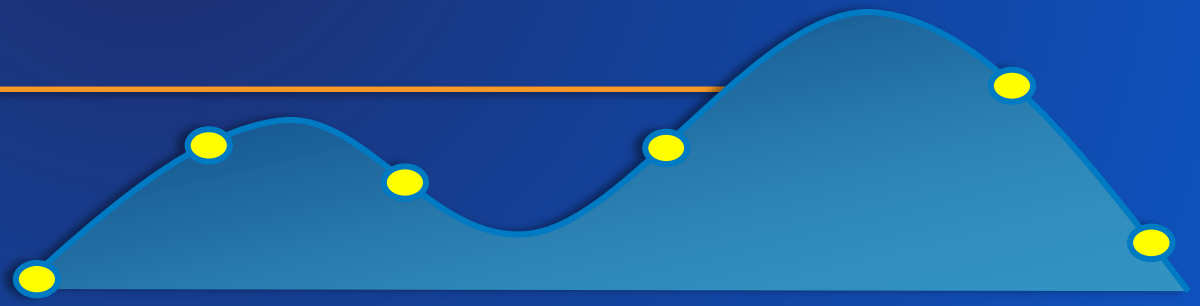


Trend

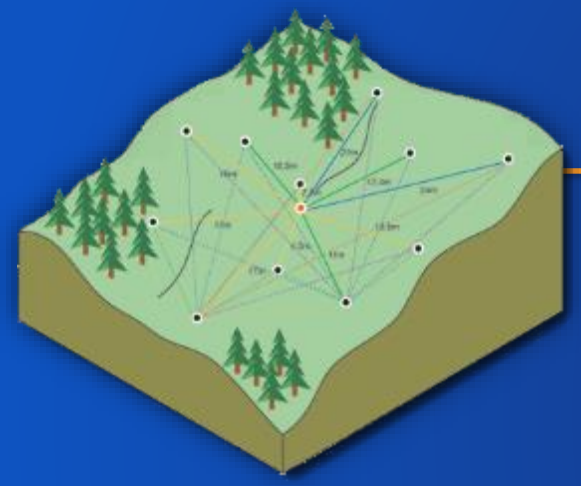
Useful for data with gradual variation (e.g. wind speed, temperature)

Spline

Predicts peaks and valleys that are not captured in the sample measurements

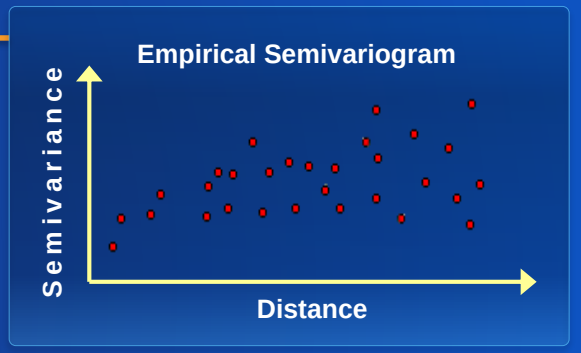


Geostatistical & Geomorphological Interpolation



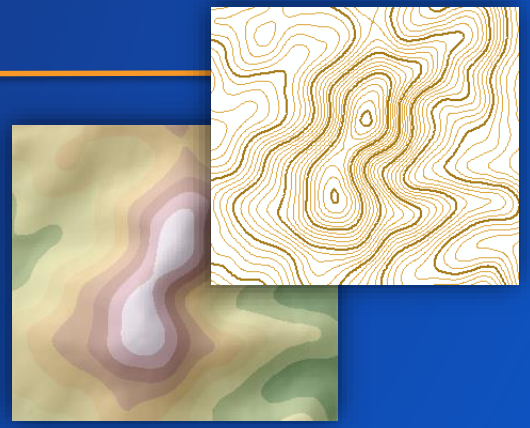
Kriging

Consider using with evenly distributed source measurements that capture local surface variation.



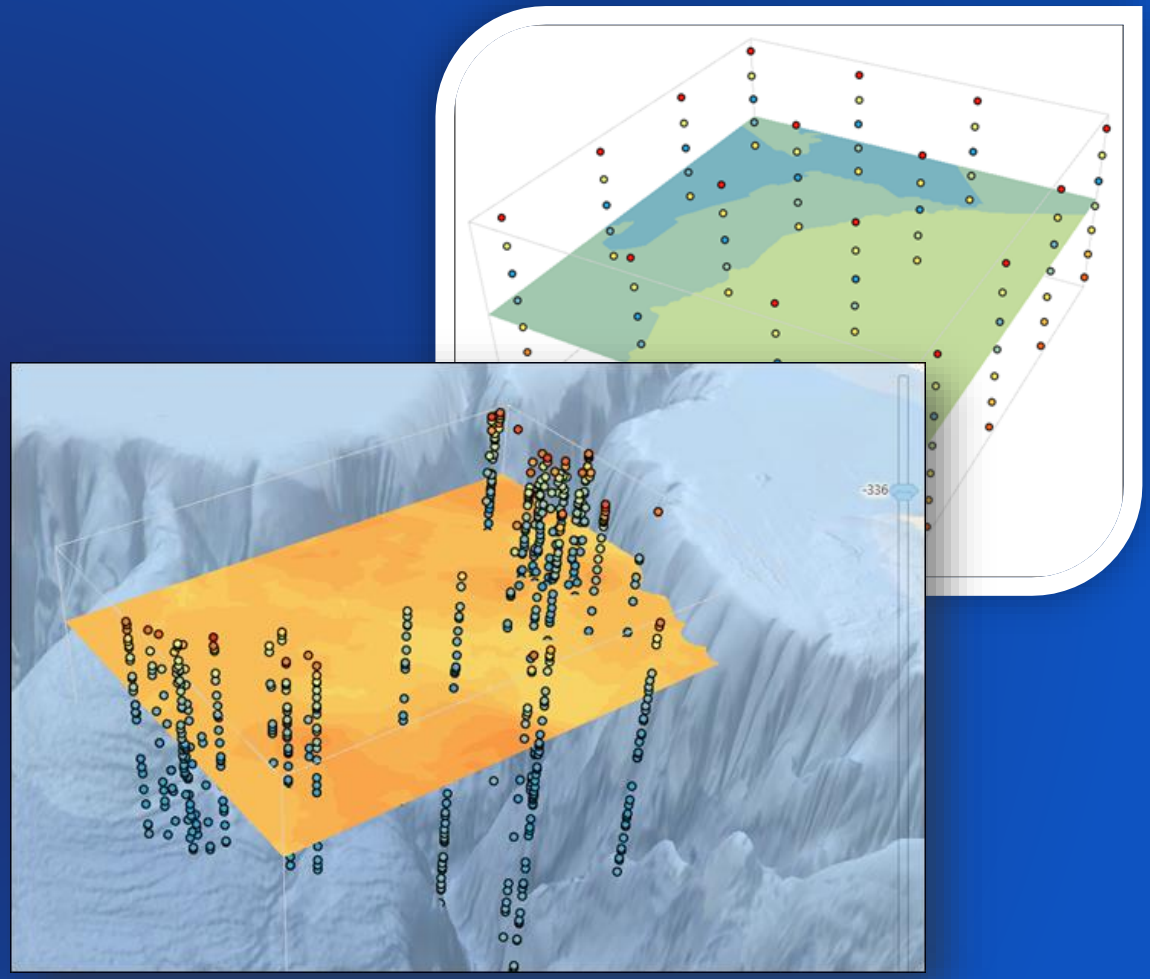
Topo To Raster

Creates hydrologically correct surface that eliminates local sinks, designed to work well with contour lines



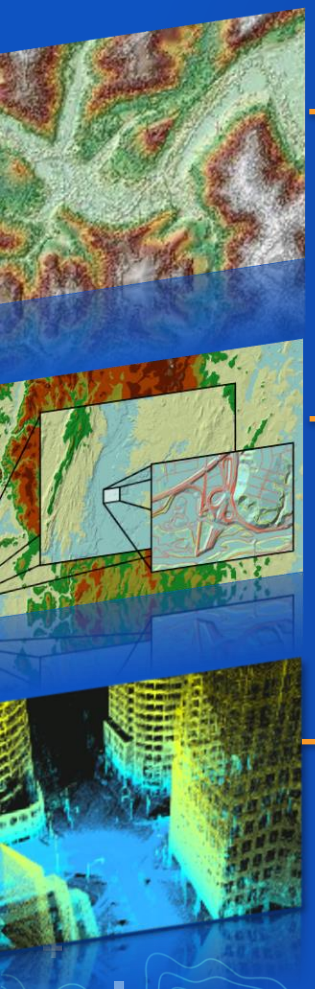
Empirical Bayesian Kriging 3D

- Predict subsurface geological properties
- Preview an iso-surface at any elevation
- Requires minimal interactive modeling
- Provides accurate results for moderately non-stationary data
- Dynamically view or export contours and raster dataset slices at any elevation
- Export regularly spaced prediction points



Kriging: An Introduction to Concepts and Applications, Thursday 4:00, Room 15B

Triangulated Irregular Network (TIN) Surfaces



TIN

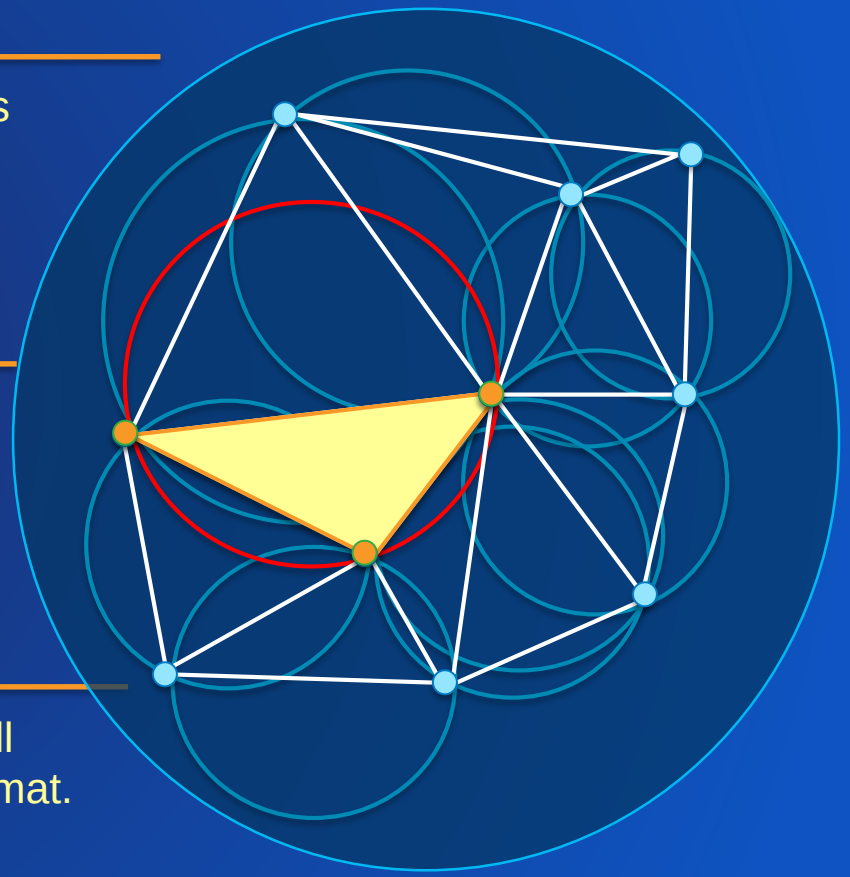
Well-suited for engineering applications and analysis of study areas that are not exceedingly large, provides interactive editing options.

Terrain

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

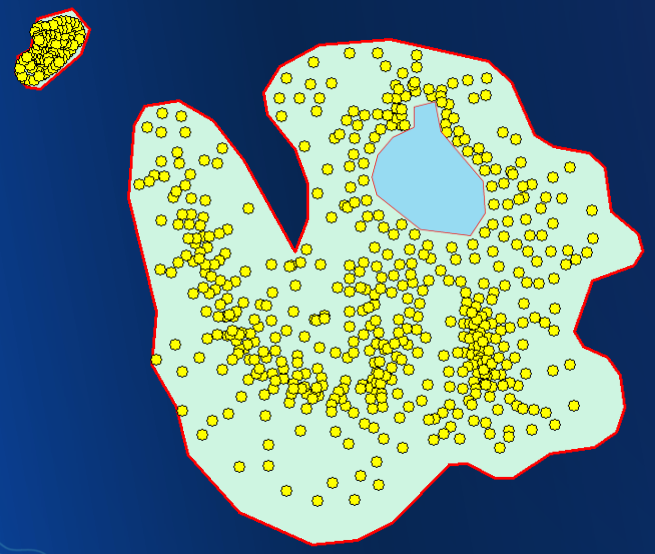
LAS Dataset

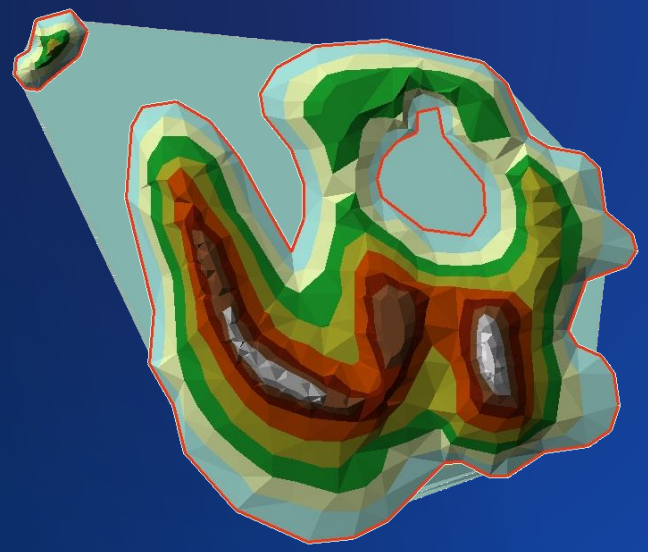
Rapidly visualize, filter, perform QA/QC and analyze lidar data. Well suited for aerial collections, supports compressed lidar in ZLAS format.



Surface Feature Types

- 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

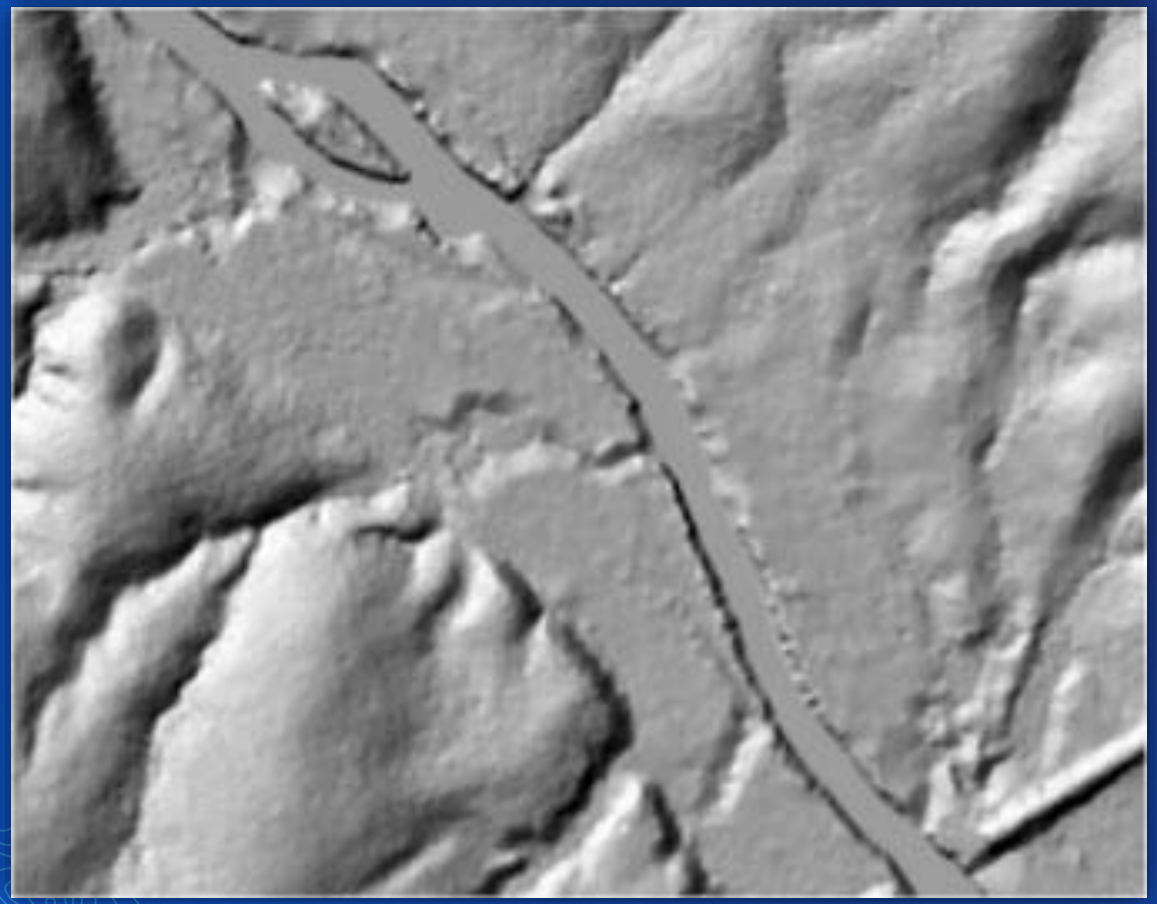


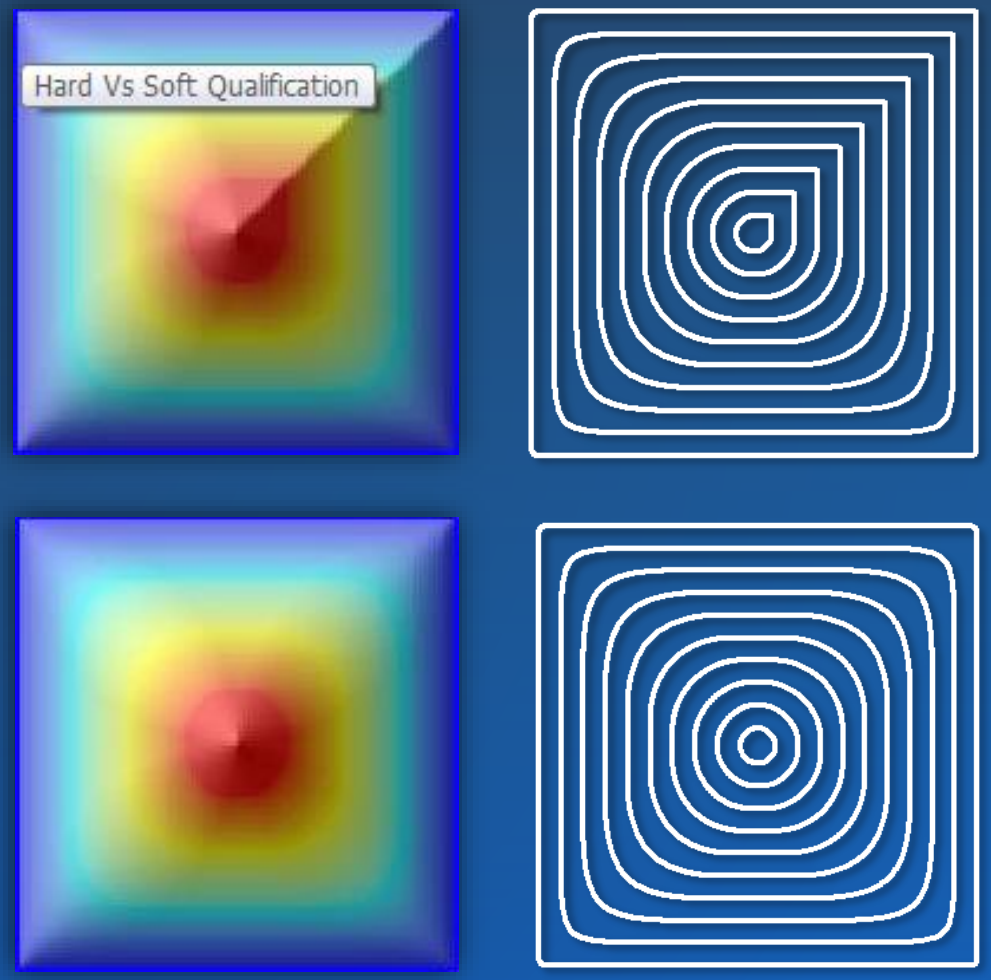


Also supports:

- Break lines
- Tag values

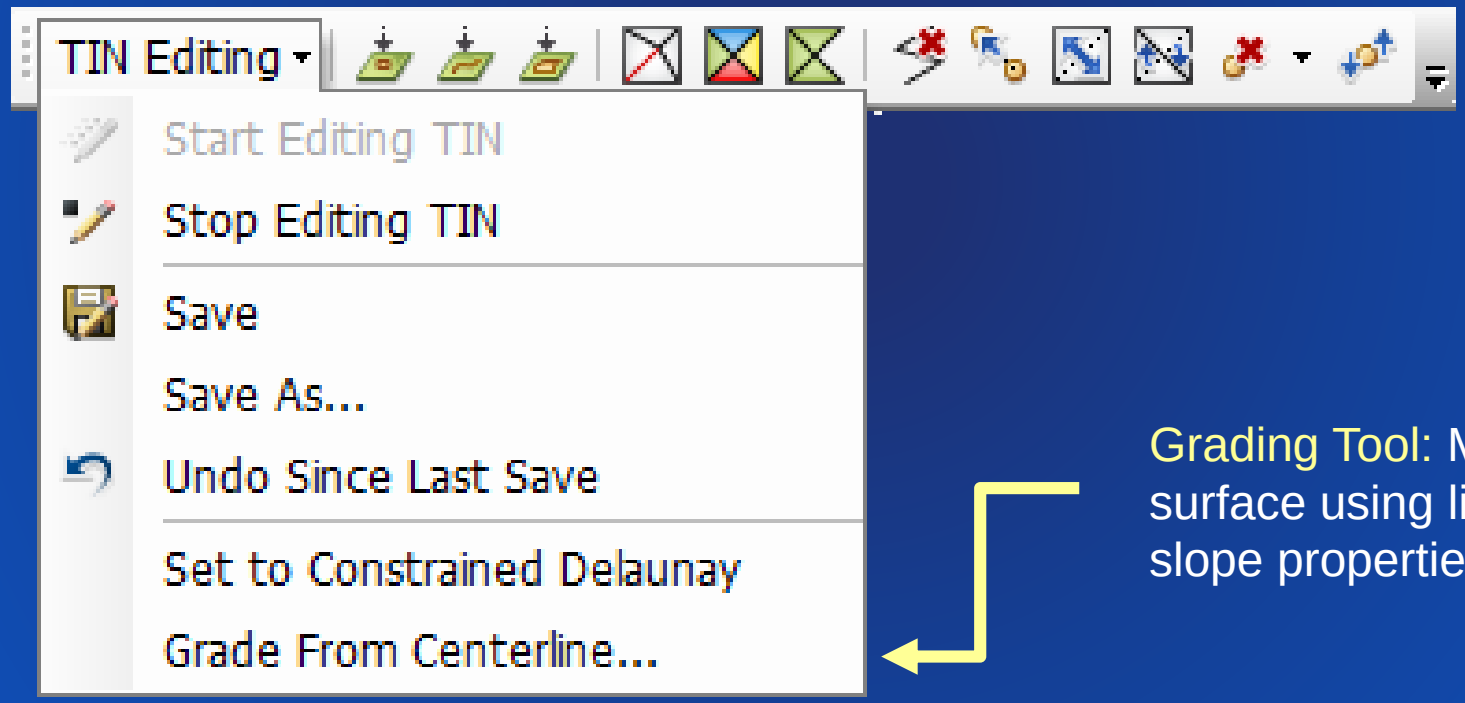
Hard & Soft Edges





TIN Editing Toolbar in ArcMap

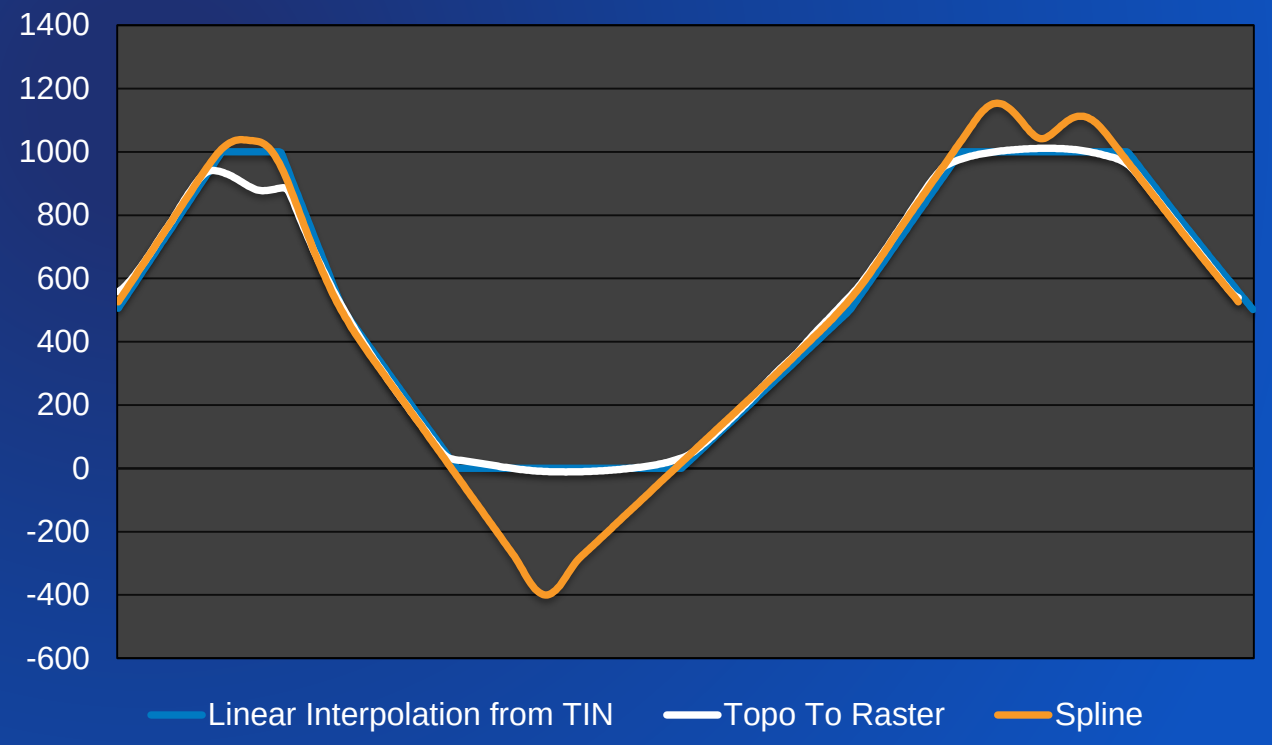
TIN Editors: Add, modify, or remove nodes, edges, triangles & tag values



Grading Tool: Modify surface using line with slope properties.

Choosing the Right Surface

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

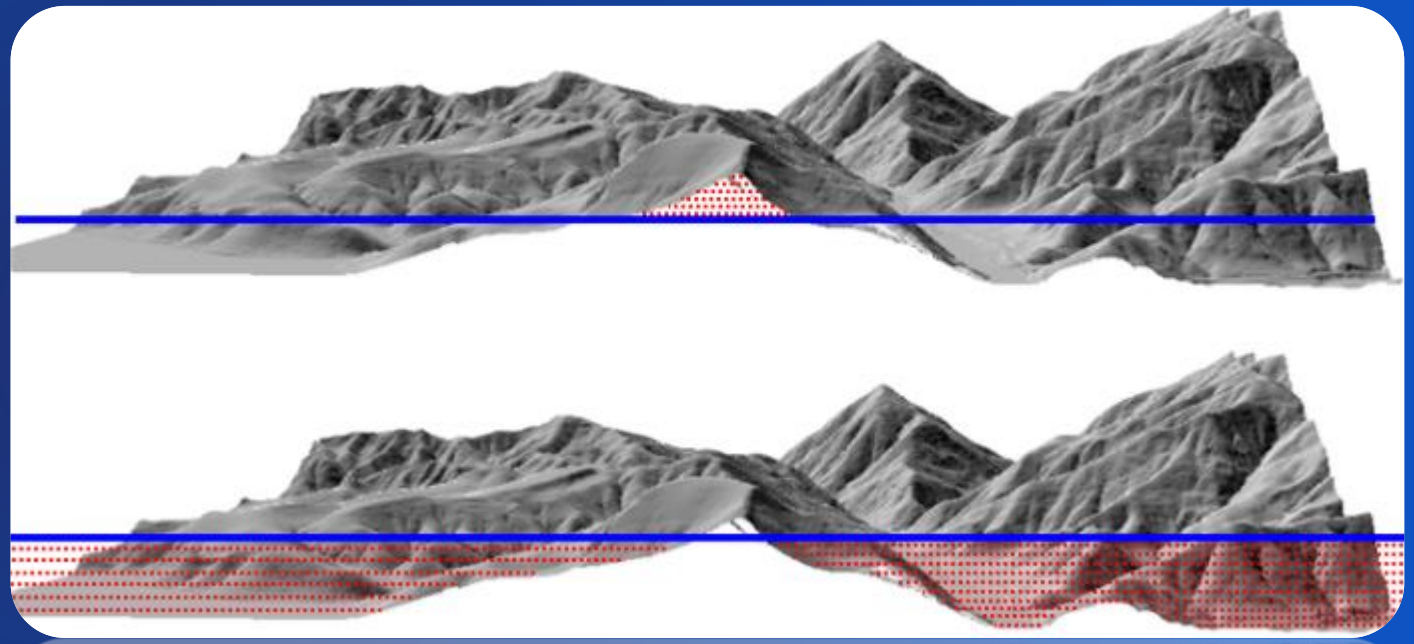


LAS & Surface Analysis

Classification | Spatial Statistics | Surface Derivatives

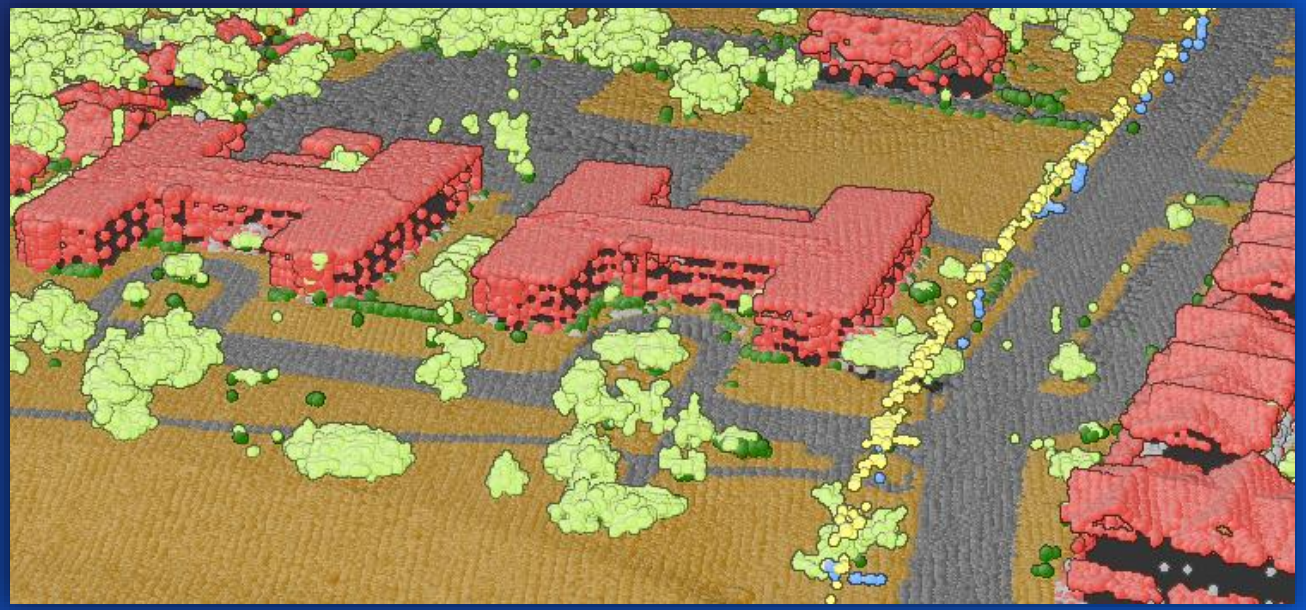
Surface Analysis

- Change detection
- Calculate area & volume
- Proximity analysis
- Robust mathematical operations
- Surface derivatives
  - Slope
  - Aspect
  - Curvature
  - Contour Lines



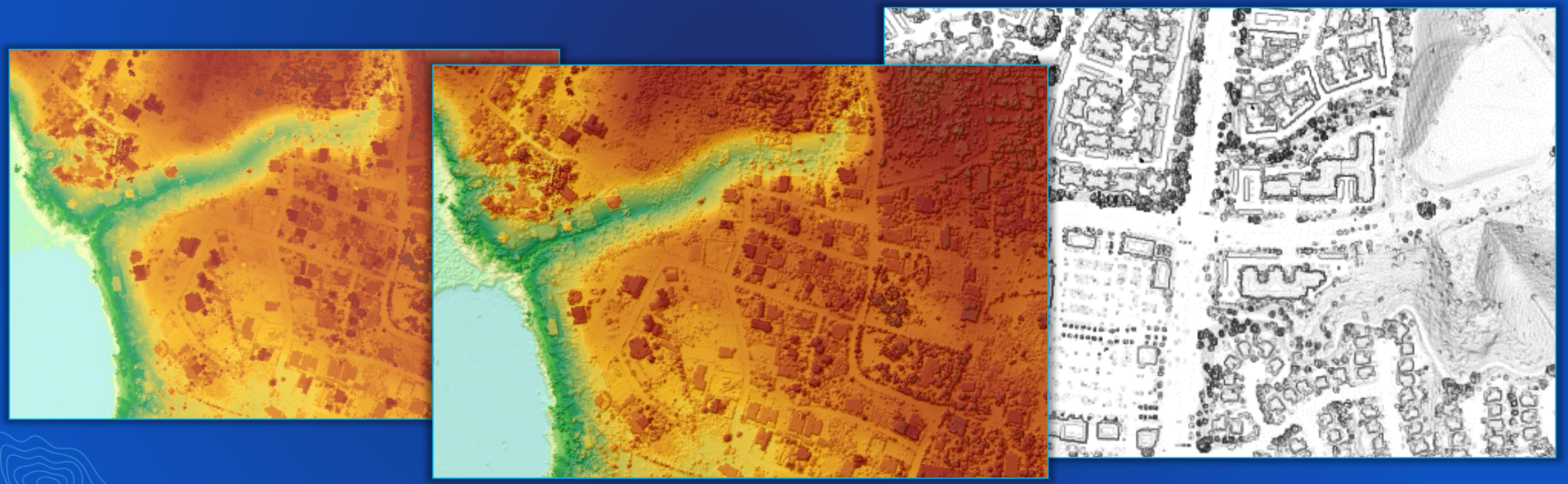
LAS Analysis

- Automated classification support:
  - Ground
  - Building
  - Noise
  - Overlap scans
  - Height above ground
  - Proximity to 2D/3D Features
- Proximity analysis
- Point statistics
- Surface derivatives



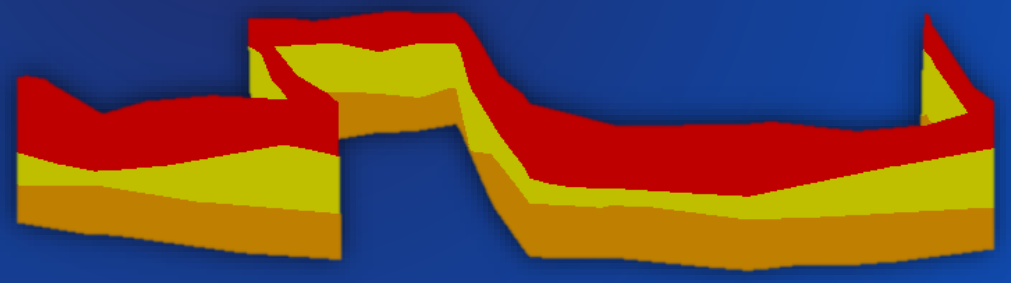
Hillshade

- Accentuates sharp features by simulating impact of a localized illumination source
- Multi-directional hillshade provides a planimetric view



Applications of LAS & Surface Analysis

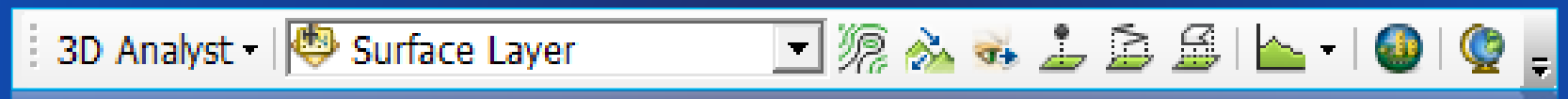
- Lidar QA/QC
- Elevation base map production
- Feature extraction workflows
- Environmental impact assessments
- Subsurface modeling



3D Analyst Toolbar in ArcMap

Interpolate Geometry: Creates 3D features based on surface Z.

Steepest Path: Determines steepest path from select point.



Target Surface Layer: Surface layer in document that will be processed by interactive tools.

Contour: Creates a single isoline at the selected point.

Profile: Creates profile graph of surface or point cloud.

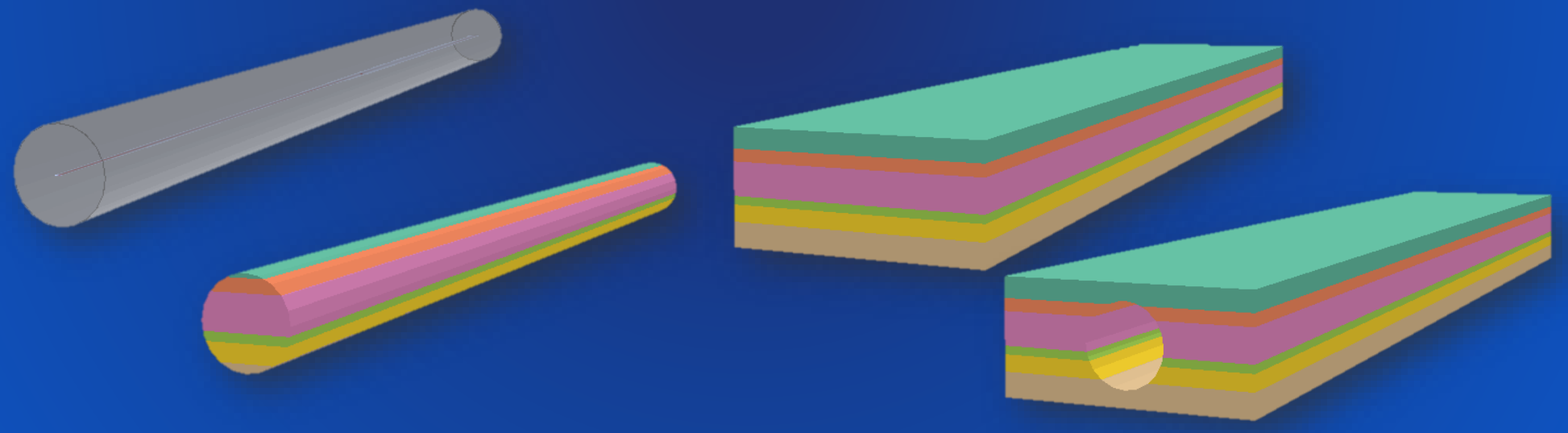
Line of Sight: Determines visibility of sight line & identifies possible obstructing point

3D Feature Analysis

Overlay | Proximity | Visibility

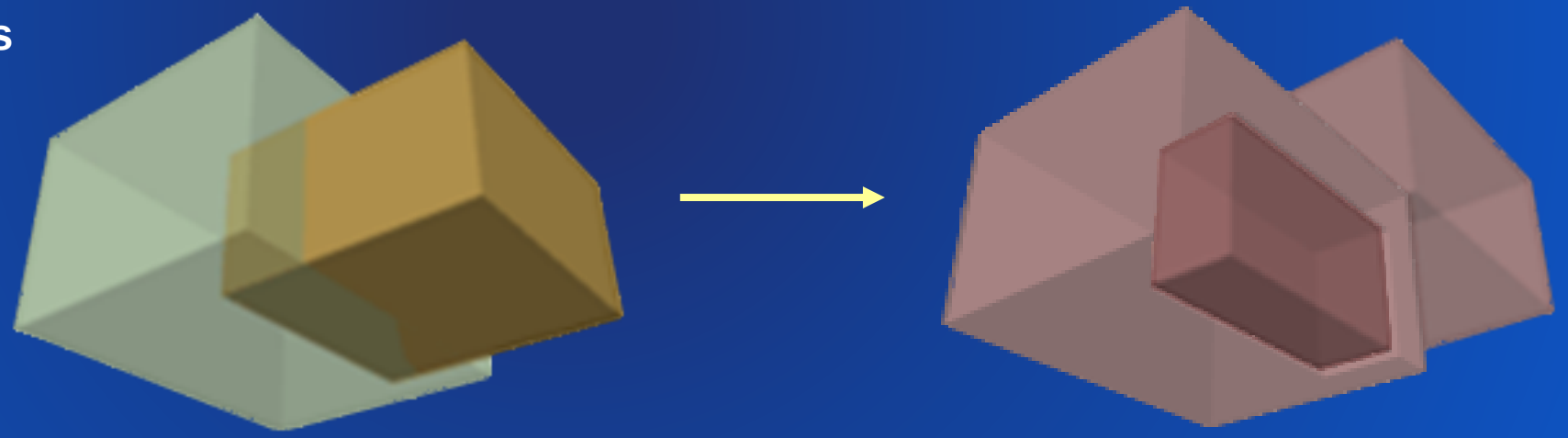
Proximity Analysis

- Create 3D buffers
- Identify closest objects
- Find intersection of 3D lines with surfaces & multipatch shapes
- Construct the minimum bounding volume encompassing a cluster of points



Volumetric Overlay Analysis

- Identify features that are inside volumetric features
- Perform geometric operations on closed volumes:
  - Difference between features
  - Overlap of feature
  - Union of features



Applications of 3D Feature Analysis

- Asset management
- Clearance/safety assessment
- Subsurface visualization & analysis
- Assessing the impact and interaction of built structures
- Modeling volumetric shells for thresholds of continuous data
- Preparing visualization for web/mobile

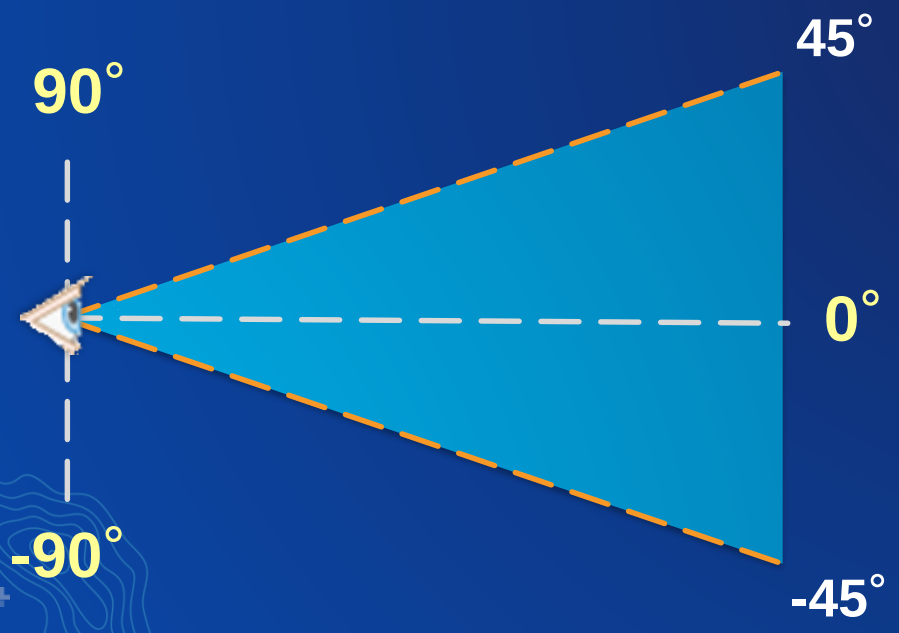
Visibility Analysis

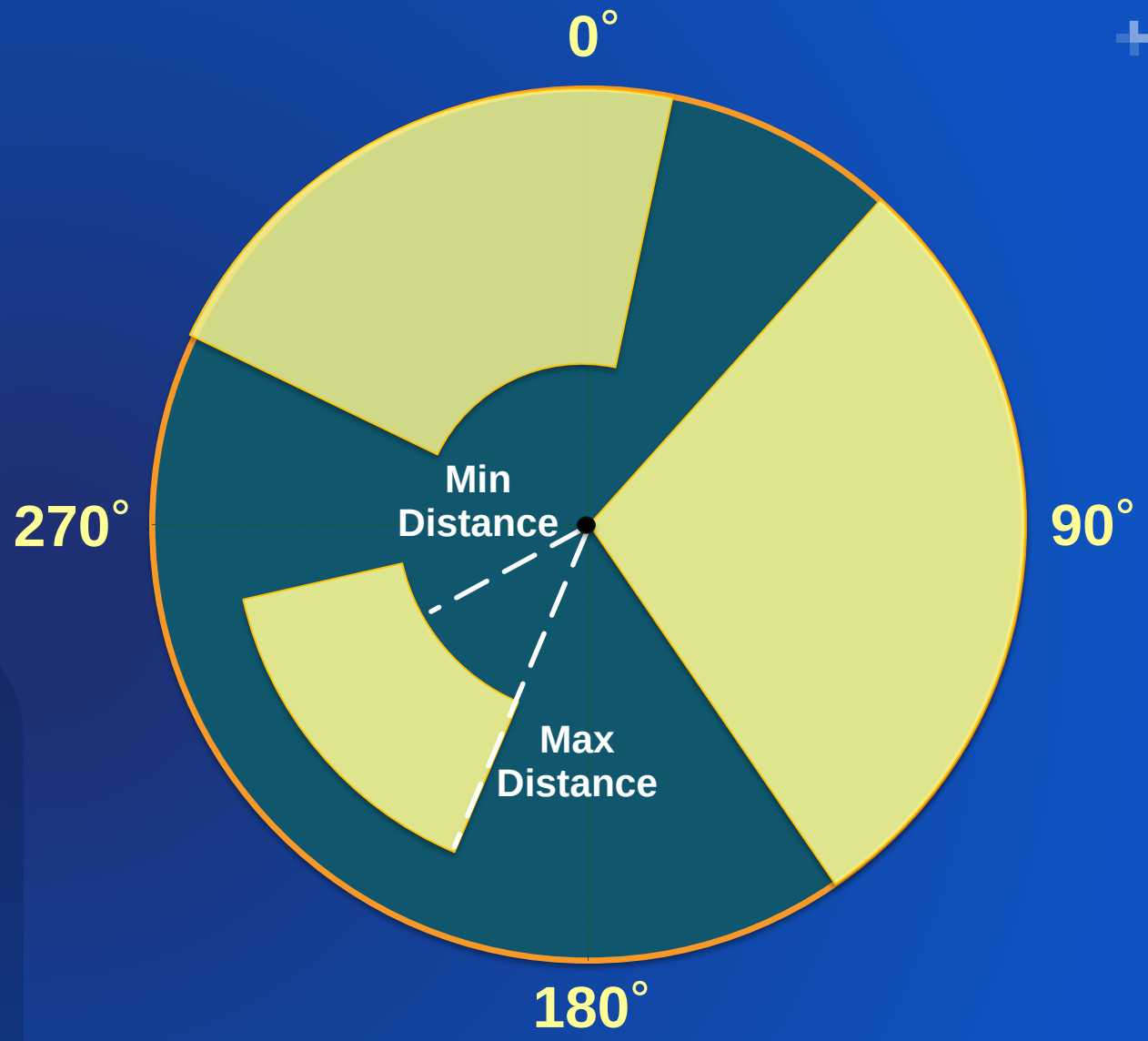
Section Subhead

Controlling the Observer

Viewshed frustum defined by:

- **Azimuth & vertical angle range**
- **Visible distance range**
- **Observer and target offset**





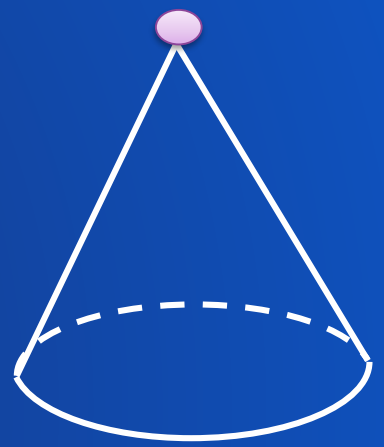
Examples of Observer Profiles

Spherical Observer

Azimuth ::: 0˚ to 360˚
Vertical Angle ::: -90˚ to 90˚
Distance ::: 0 to 100 meters

Conical Observer

Azimuth ::: 0˚ to 360˚
Vertical Angle ::: -60˚ to -90˚
Distance ::: 0 to 12 meters

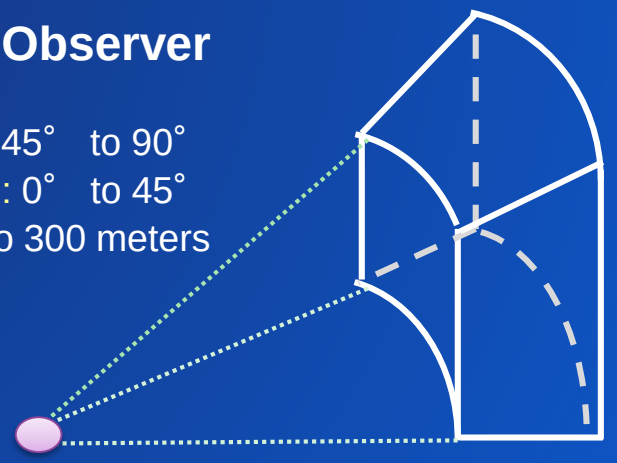


Hemispherical Observer

Azimuth ::: 0˚ to 360˚
Vertical Angle ::: 0˚ to 90˚
Distance ::: 45 to 100 meters

Distance Offset Observer

Azimuth ::: 45˚ to 90˚
Vertical Angle ::: 0˚ to 45˚
Distance ::: 250 to 300 meters

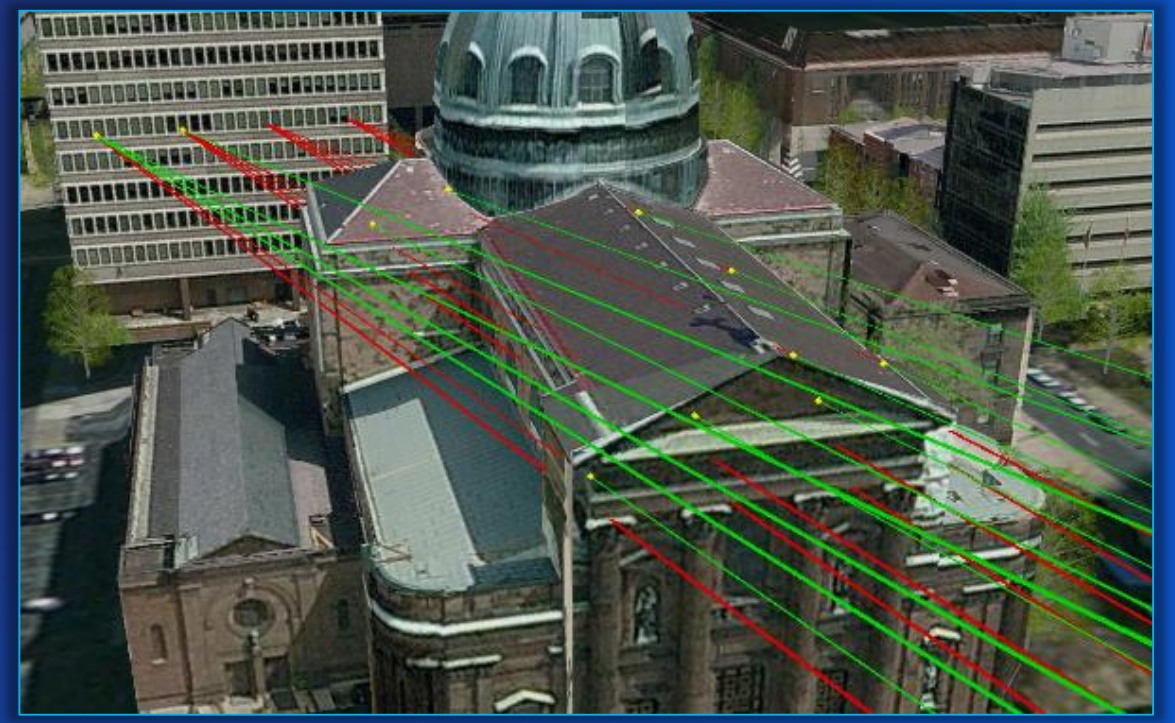


Atmospheric Refraction

- Bending of light passing through the atmosphere
- Influenced by variations in air pressure, density, humidity, temperature & elevation
- Refraction coefficient supported in:
  - Line of Sight
  - Skyline
  - Viewshed
  - Solar Radiation

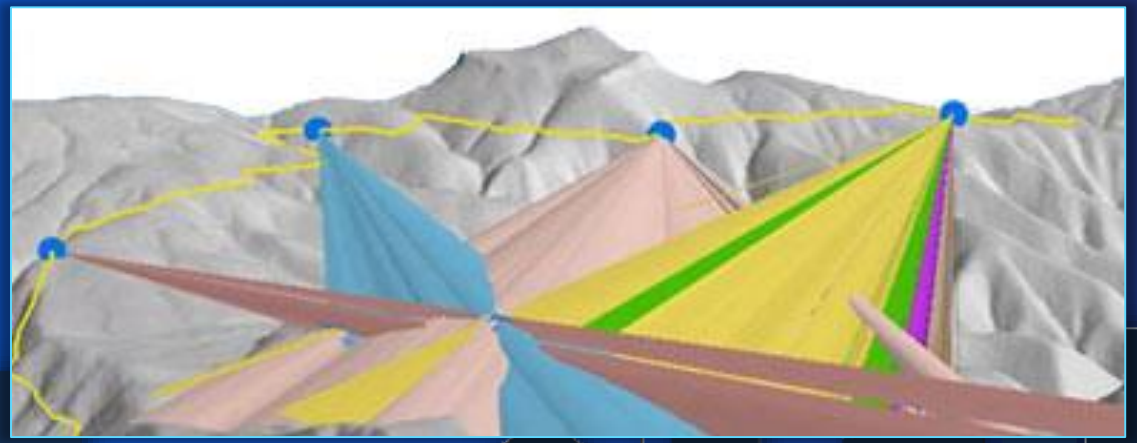
Sightline Analysis

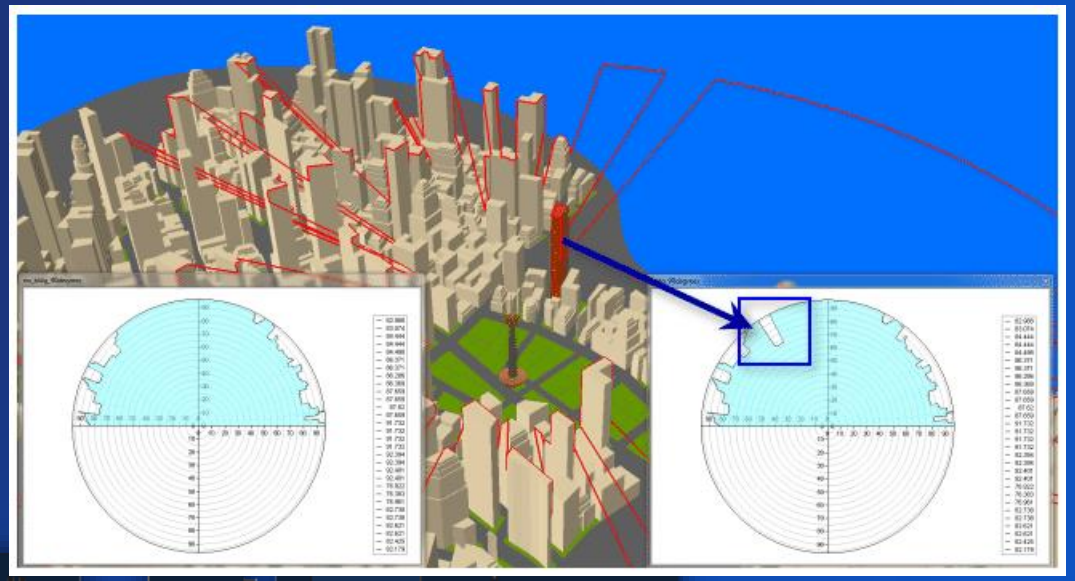
- Visibility along 2-vertex line in 3D space
- Identify obstruction point
- Interactively generate and manipulate a sightline for exploratory analysis



Skyline Analysis

- Segment the horizon by its contributing features
- Create closed volumes bounded by the skyline



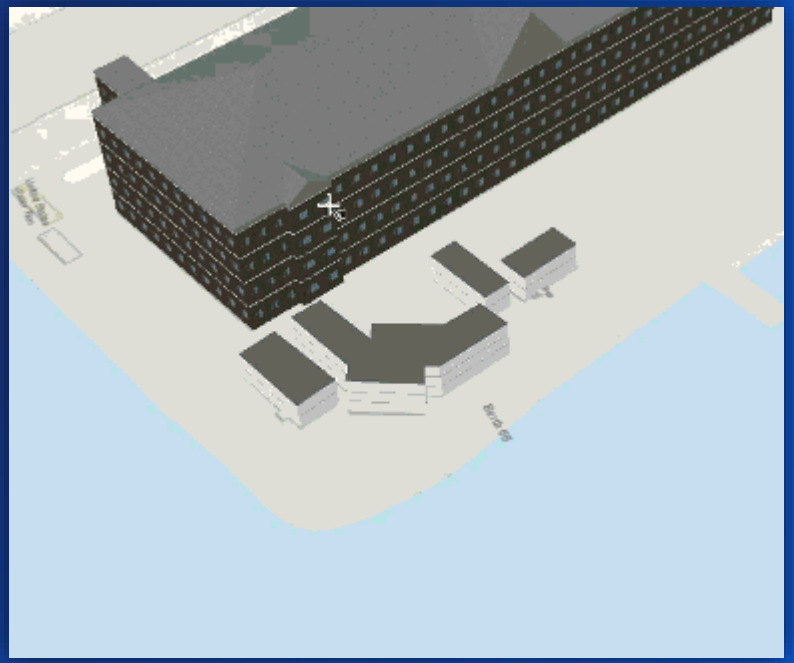


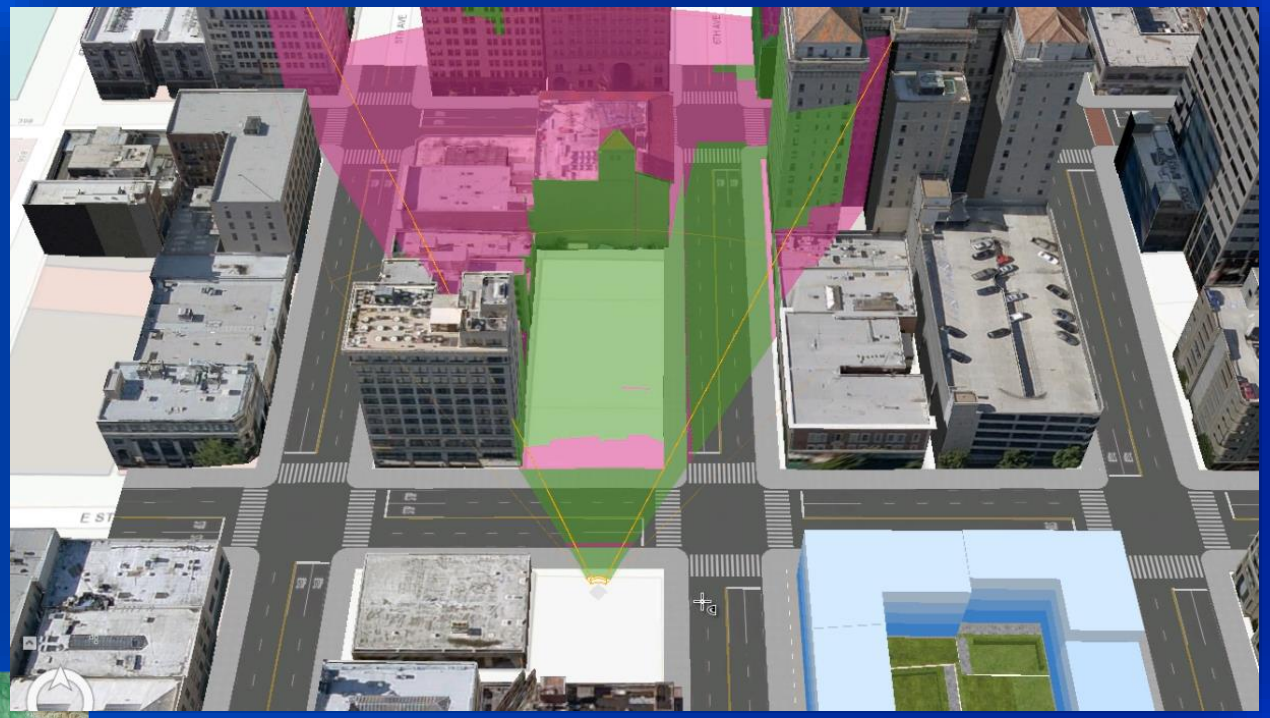
Sun Shadow Analysis

- **Create closed volumes modeling shadow cast from sunlight**
- **Determine shadow frequency on surface**
  - Right-to-light studies
  - Urban heat island estimation

Viewshed

- Identifies what can be seen from an observer over a vast tract of space
- Automated viewshed supports target offset
- Interactive viewshed supports real-time changes to scene/observer



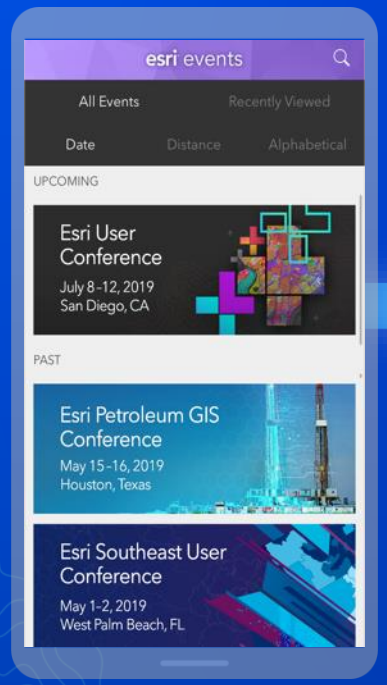


3D Analysis Demos

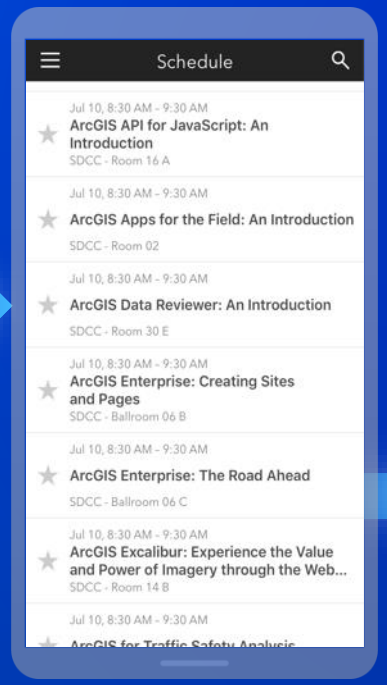
Using Exploratory & Automated Tools

Please Share Your Feedback in the App

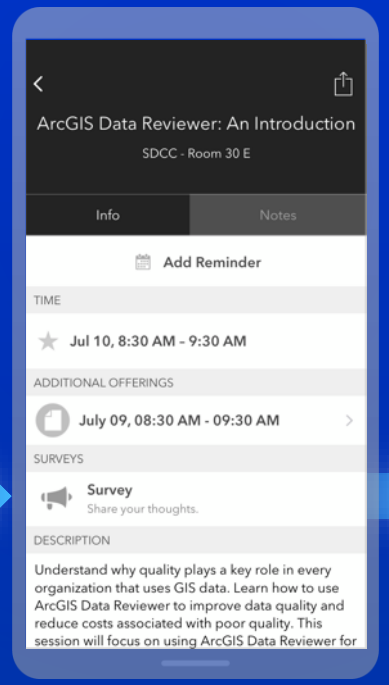
Download the Esri Events app and find your event



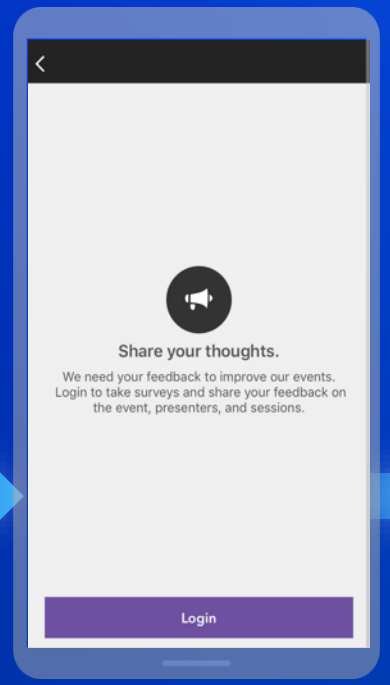
Select the session you attended



Scroll down to "Survey"



Log in to access the survey



Complete the survey and select "Submit"