

Introduction to 3D Analysis

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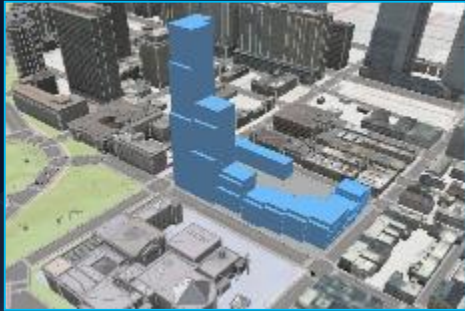
Workshop Overview

Introduction to 3D Analysis

- Scope of 3D GIS
- Overview of Analysis
 - What's New in ArcGIS Pro
 - Understanding 3D Data Types
- Review of Surface Analysis
- Review of 3D Feature Analysis
- Conclusion | Q & A

Why 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
certain ideas

What is 3D GIS?



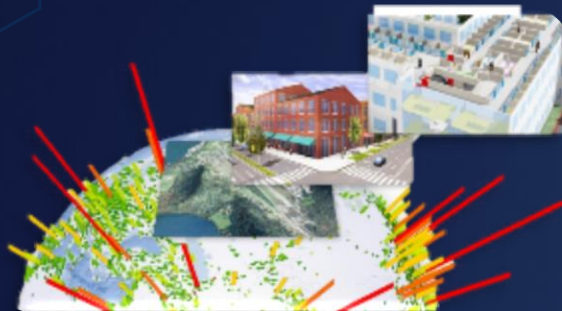
ArcGIS for 3D Cities



Share 3D scenes



3D Geodesign



Multiscale 3D Models



Lidar support



3D Analysis



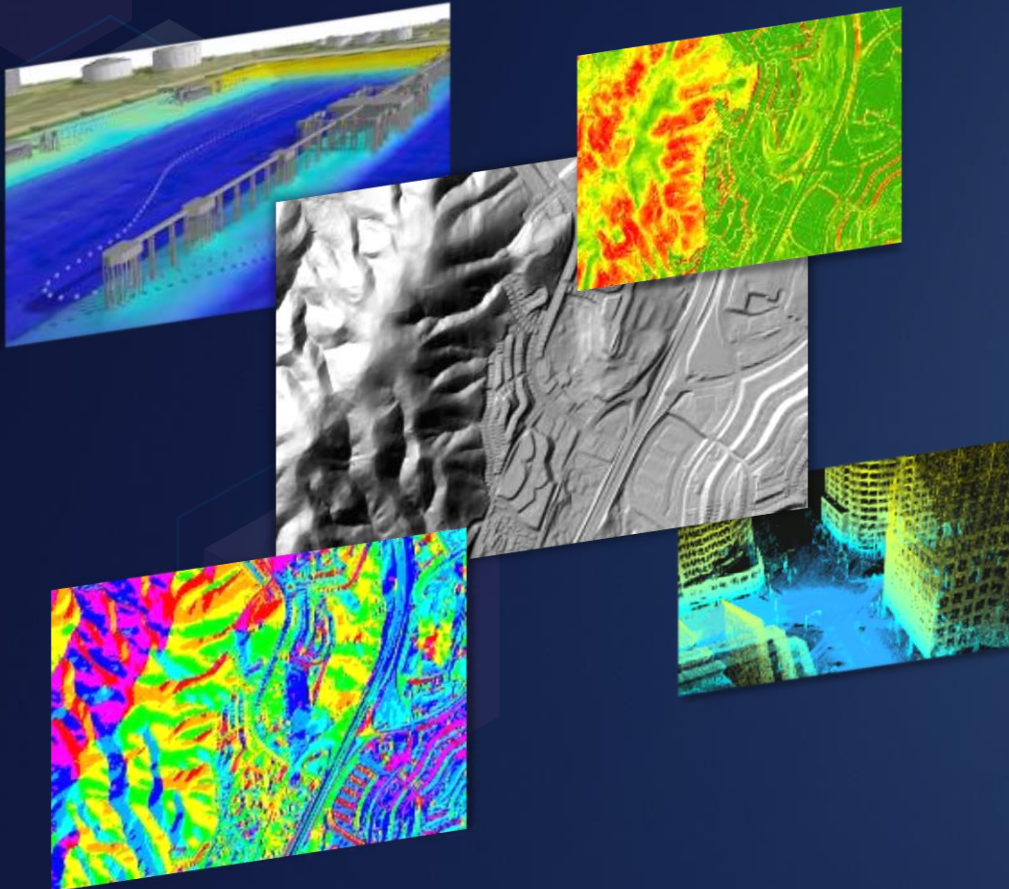
Integrated 3D



Surface modeling

Expand the Horizon of 3D GIS

Summary of 3D Analyst Capabilities



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

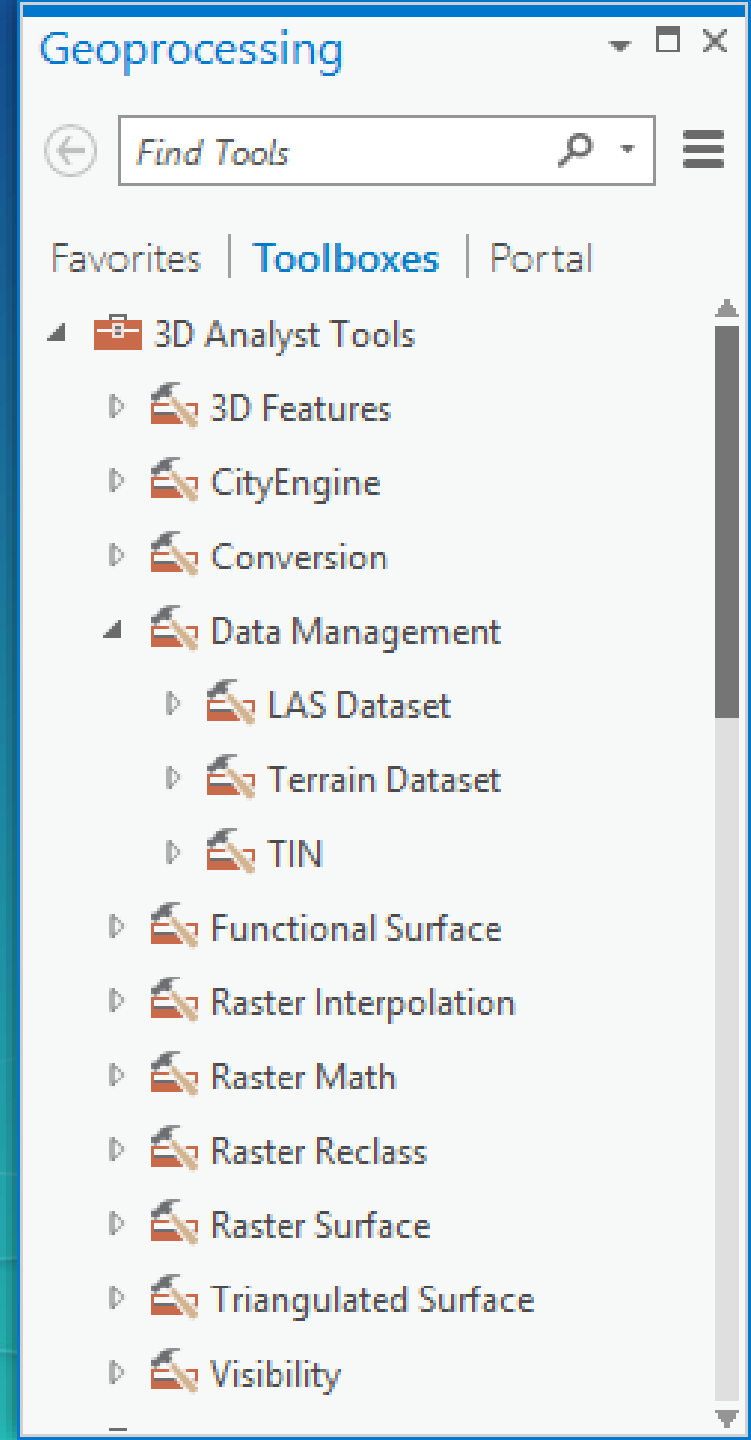
- 3D Statistics
- 3D Proximity
- 3D Intersections
- Visualization
- Profile Graphs
- Interpolate Features
- Extrude Between Surfaces
- Extract Buildings from Lidar

Visibility

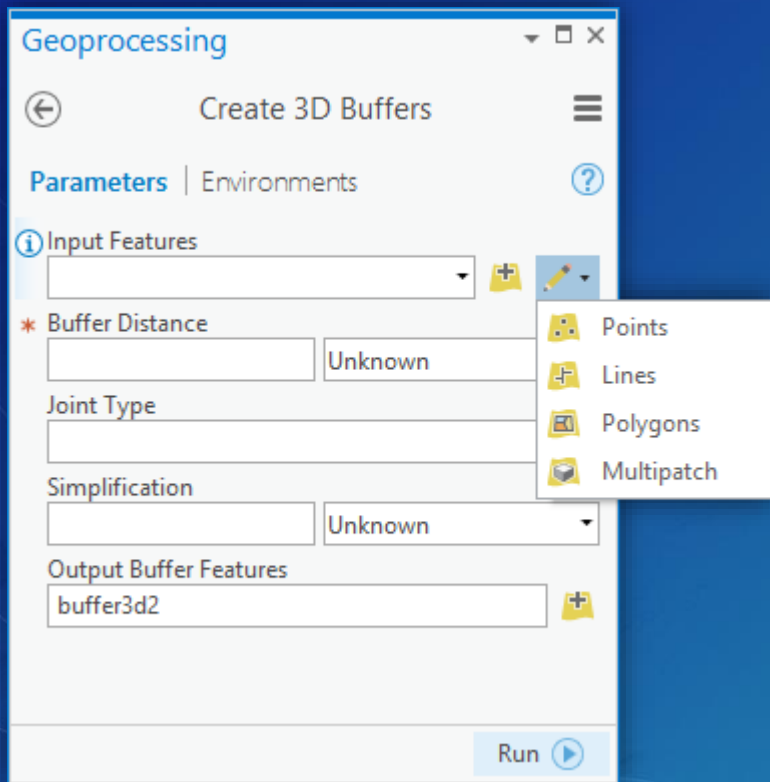
- Sight Line Analysis
- Viewshed Determination
- Skyline Analysis
- Shadow Modeling
- Hillshade

3D Analyst Toolbox

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



Interactive Inputs for Geoprocessing



- Point, line and polygon geometry can be interactively defined for tools
- Many geoprocessing tools now also support this capability directly
- Feature set control can be assigned for custom script tools and models

What's New for 3D Analysis in Pro

- New automated lidar classification and feature extraction tools
 - ↳ Classify noise, overlap points
 - ↳ Create 3D building models from lidar
- Direct read of LAS/ZLAS files without using a LAS dataset
- Enhanced support for LAS dataset in geoprocessing tools
- Modulate lidar point display using intensity for improved visualization
- LAS dataset properties overview from the Catalog view/pane
- Improvements to Slope and Aspect calculations for raster surfaces
- Spline With Barriers raster surface interpolation tool

3D Information

Understanding Data Types Used in 3D GIS



How is XYZ information represented?

Vector Data

Points | Lines | Polygons

Mesh Geometry

Lidar

Thematic Layers

CityEngine RPKs

NetCDF

Scene Layers



Surface

TIN

Lidar

Raster

Mosaic

Terrain

NetCDF

Understanding the 3D Mesh

- Collection of points used to construct triangle faces that define true 3D data
- Support rendering properties like textures, colors, and transparency
- Can be used to represent any type of data, including:
 - Buildings
 - Vegetation
 - Complex terrains
 - Street furniture
 - Building interior models



Multipatch Geometry

- Original mesh geometry storage format for ArcGIS
- Supports textures when stored in a geodatabase
- Single resolution dataset
- Can be constructed by:
 - ↳ Editing in ArcGIS Pro
 - ↳ Deriving from surface analysis
 - ↳ Importing from 3D model formats
 - ↳ Exporting from points, lines, and polygons with 3D symbology properties



Indexed 3D Scene Layers (I3S)

- Open standard data format
- Container for large collections of 3D data which supports
- Multi-resolution dataset optimized for streaming across a network
- Can be viewed on a wide variety of clients
- Supports the following formats:
 - Points
 - Point cloud
 - 3D objects
 - Integrated mesh



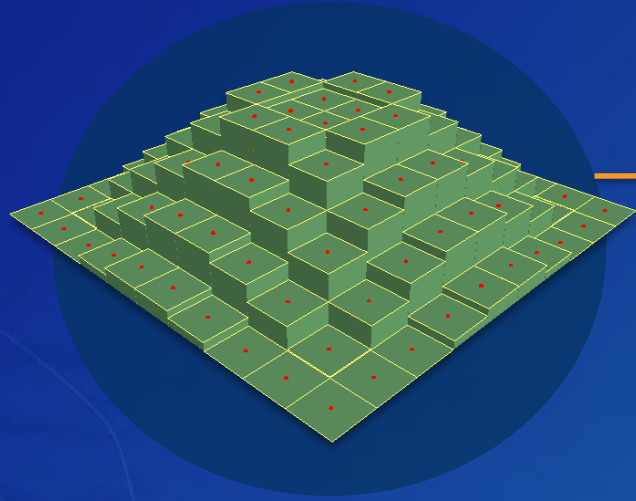
Understanding the Surface

A continuous measurement that represents one Z value for a given XY location



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

Surface Data Models

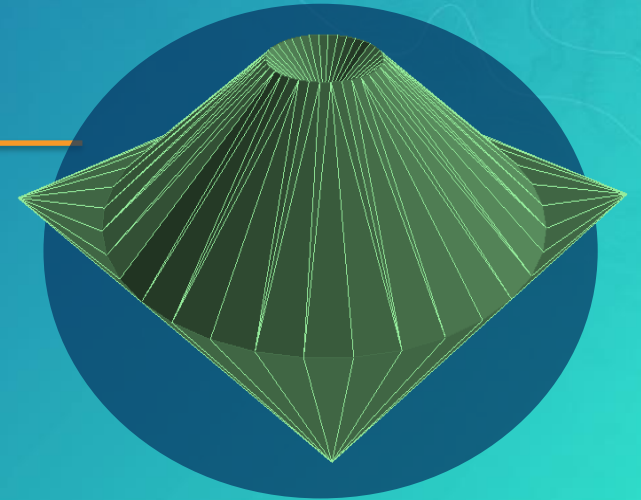


Raster Surface

- 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

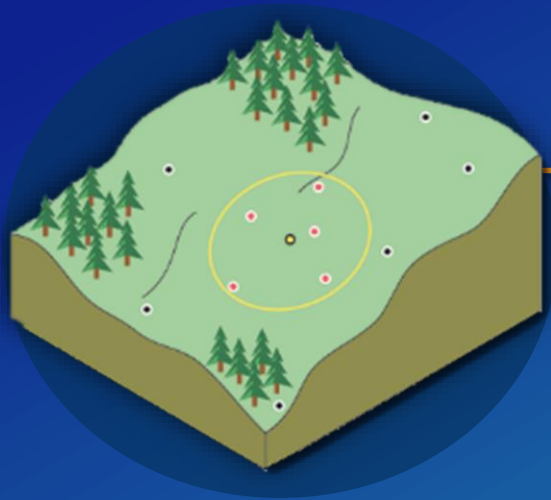


Raster Surface

Understanding Interpolation Techniques



Distance Based Interpolation

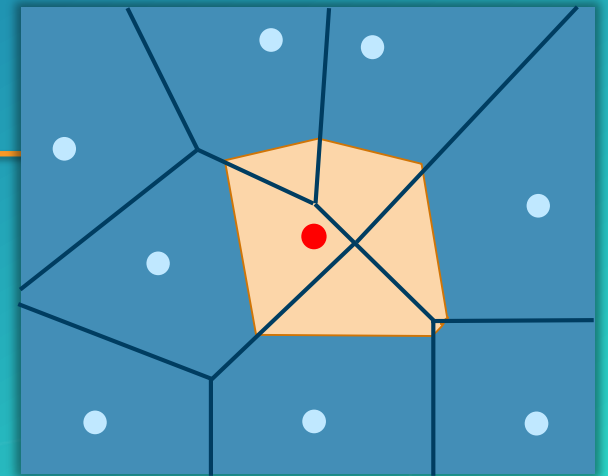


Inverse Distance Weighted (IDW)

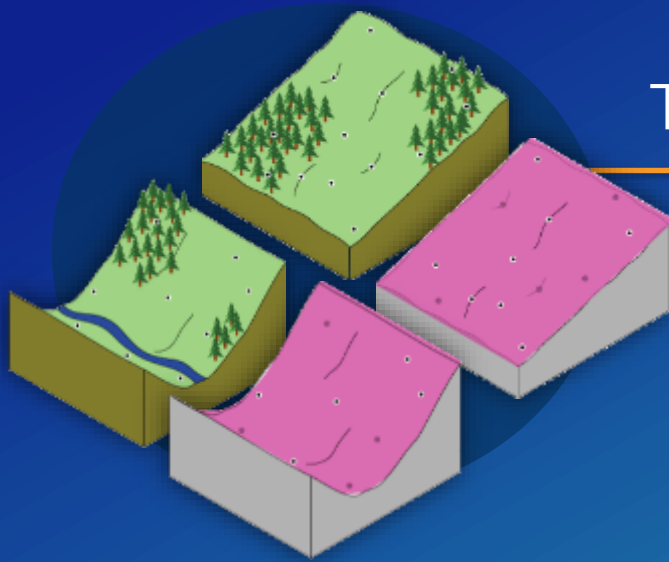
Consider using with evenly distributed source measurements that capture local surface variation.

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

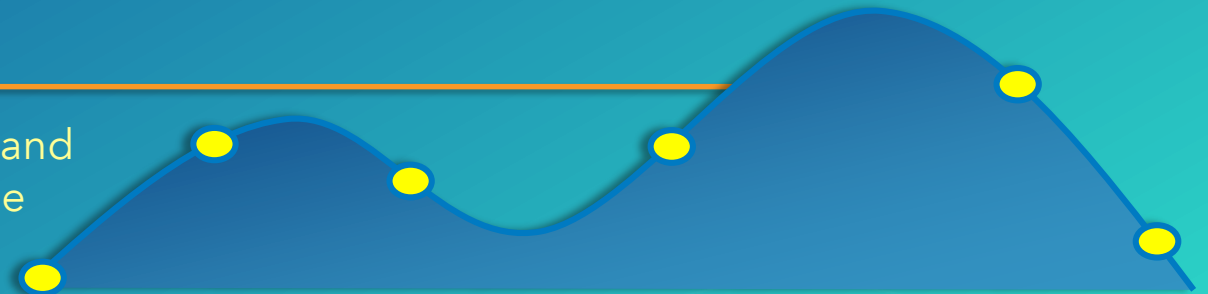


Trend

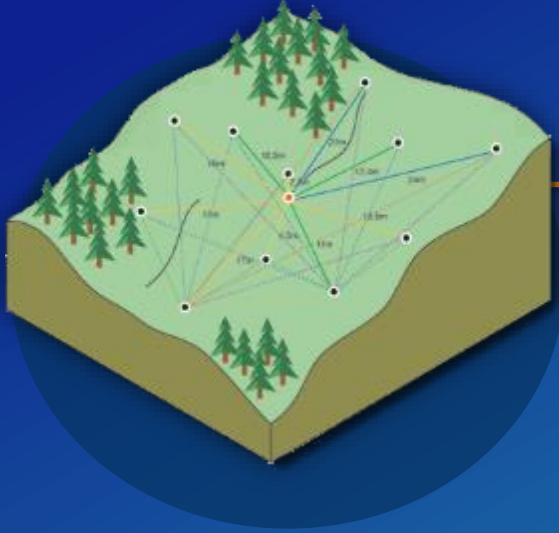
Useful for data with gradual variation (e.g. wind speed, temperature)

Spline

Consider using to interpolate peaks and valleys that are not represented in the sample measurements.

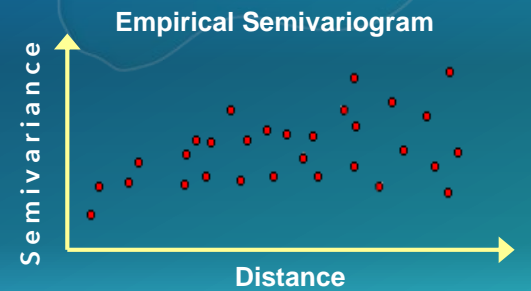


Additional Interpolators



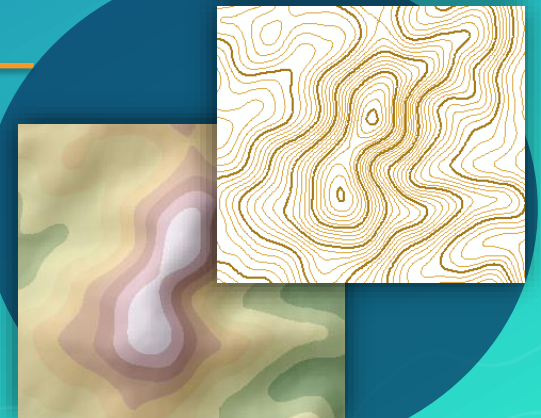
Kriging

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



Topo To Raster

Consider using to interpolate peaks and valleys that are not represented in the sample measurements.



Triangulated Irregular Network (TIN) Surface

Understanding TIN Surface Modeling



Triangulated Irregular Network (TIN) Surfaces

TIN

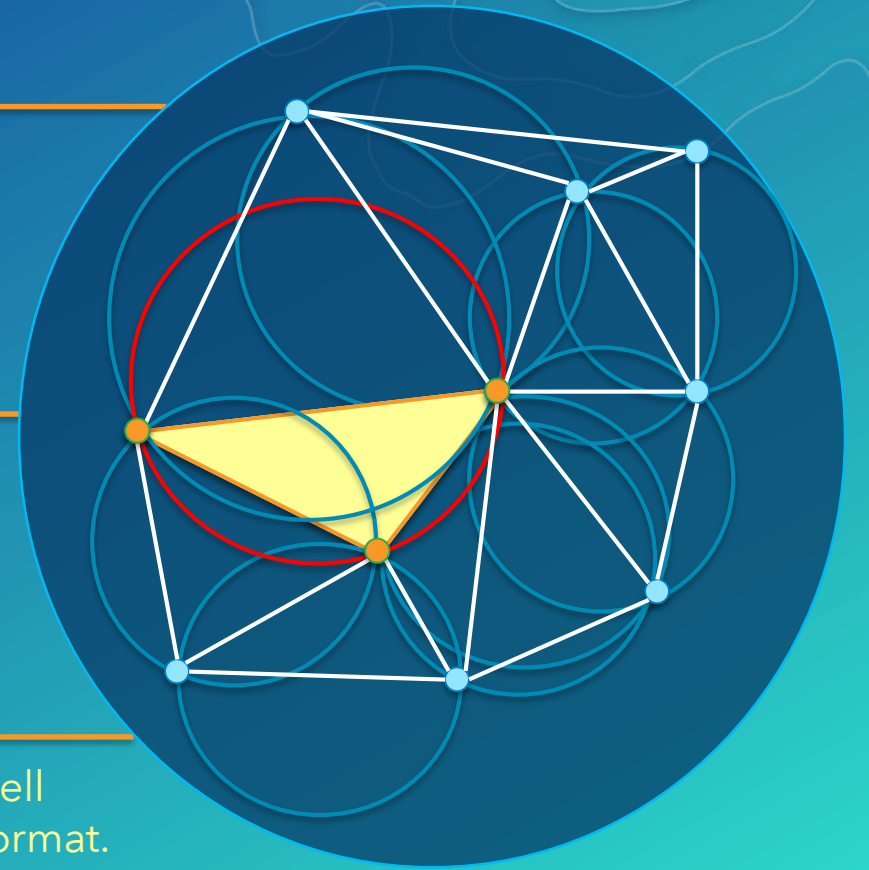
Well-suited for engineering applications and analysis of study areas that are not exceedingly large, provides interactive editing options.

Terrain

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

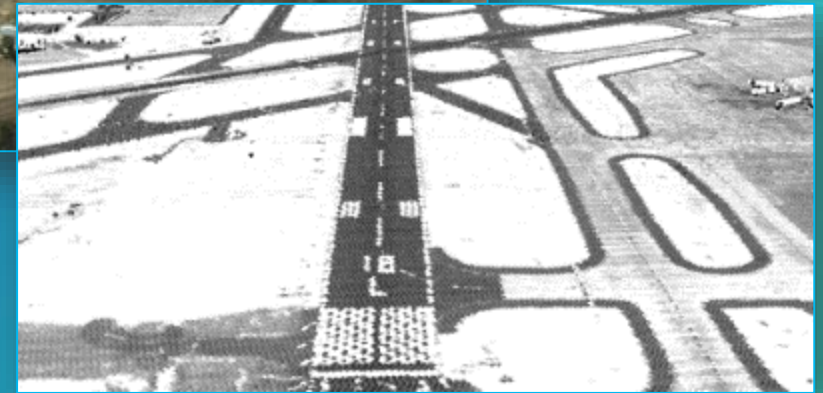
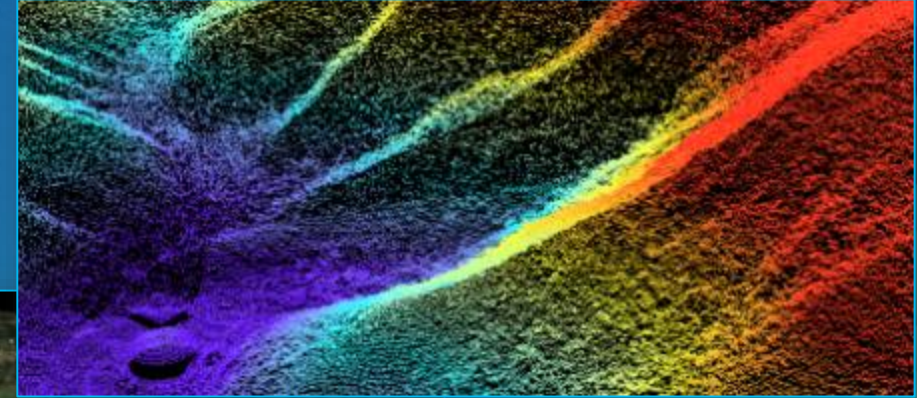
LAS Dataset

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



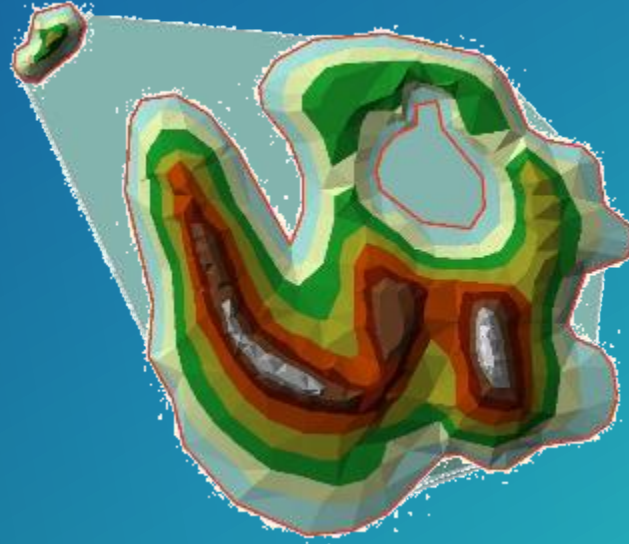
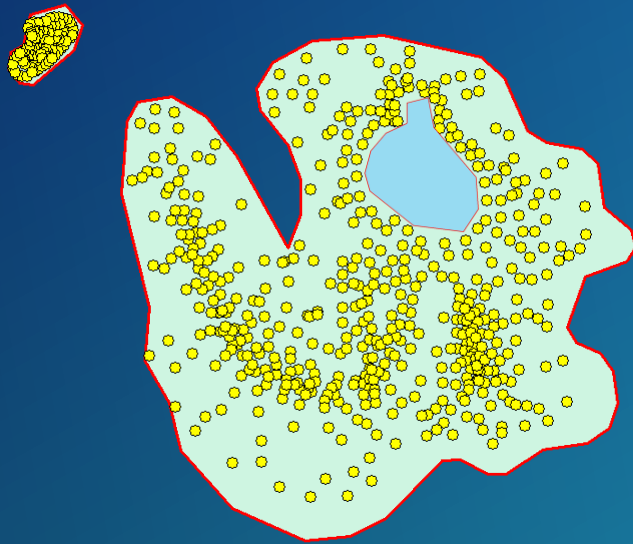
Doing More with Lidar

- Automated classification:
 - ↳ Ground
 - ↳ Buildings
 - ↳ Height above ground
 - ↳ Noise
 - ↳ Interactive classification
- Clip, tile, and project lidar
- Perform QA/QC
- Statistical analysis
- DEM/DSM production



TIN Surface Features

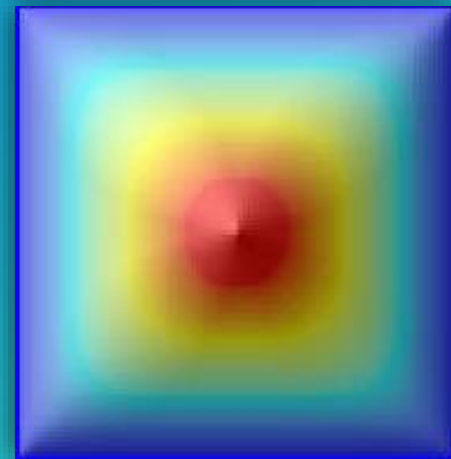
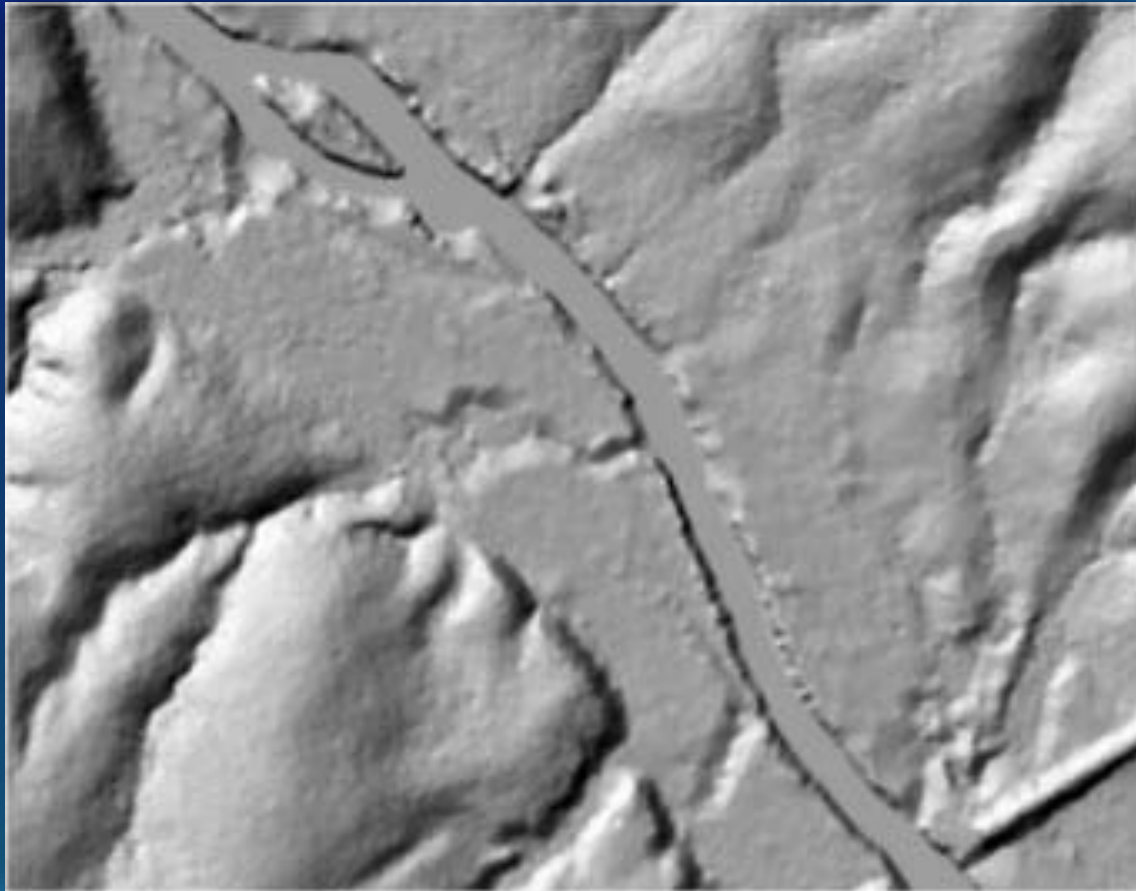
- **Mass points:** Measurements used for triangulation
- **Erase polygon:** Interior areas of no data
- **Replace polygon:** Assigns a constant z value
- **Clip polygon:** Defines the interpolation zone



Also supports:

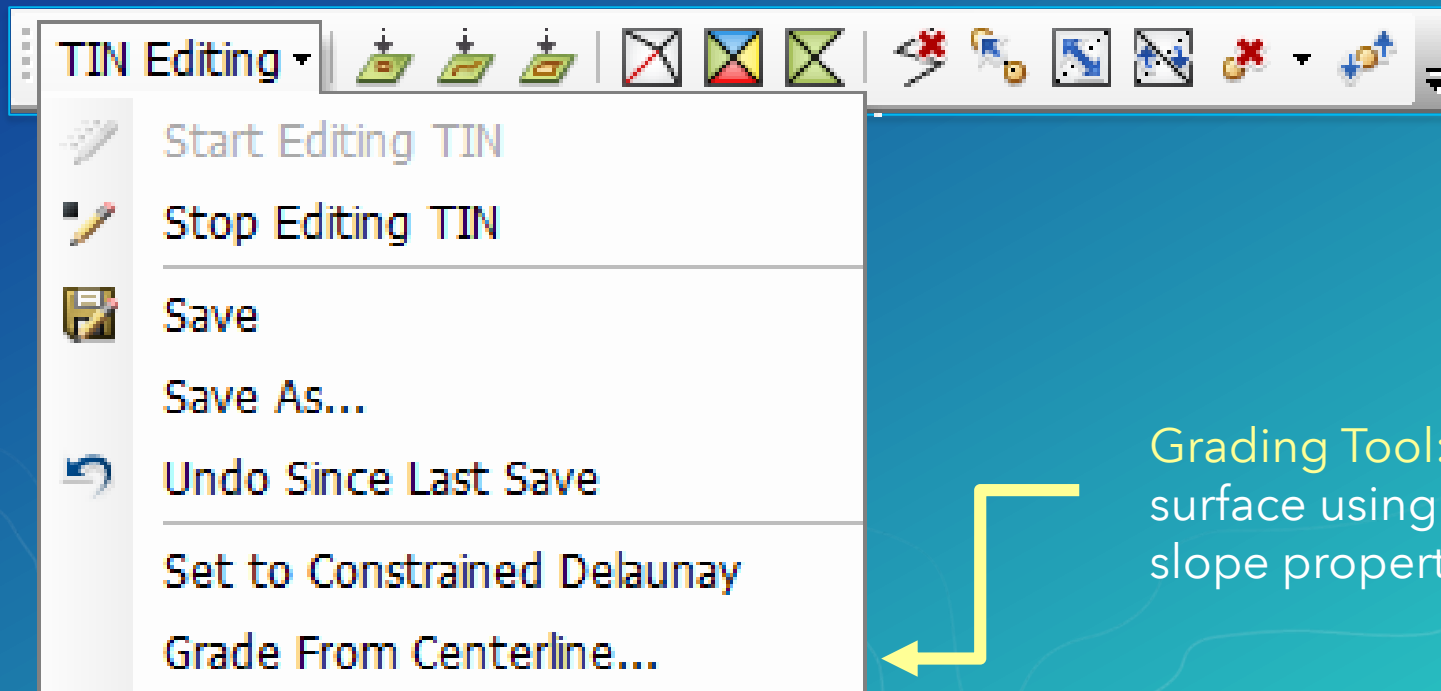
- Break lines
- Tag values

Hard/Soft Breaklines



TIN Editing in ArcMap

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

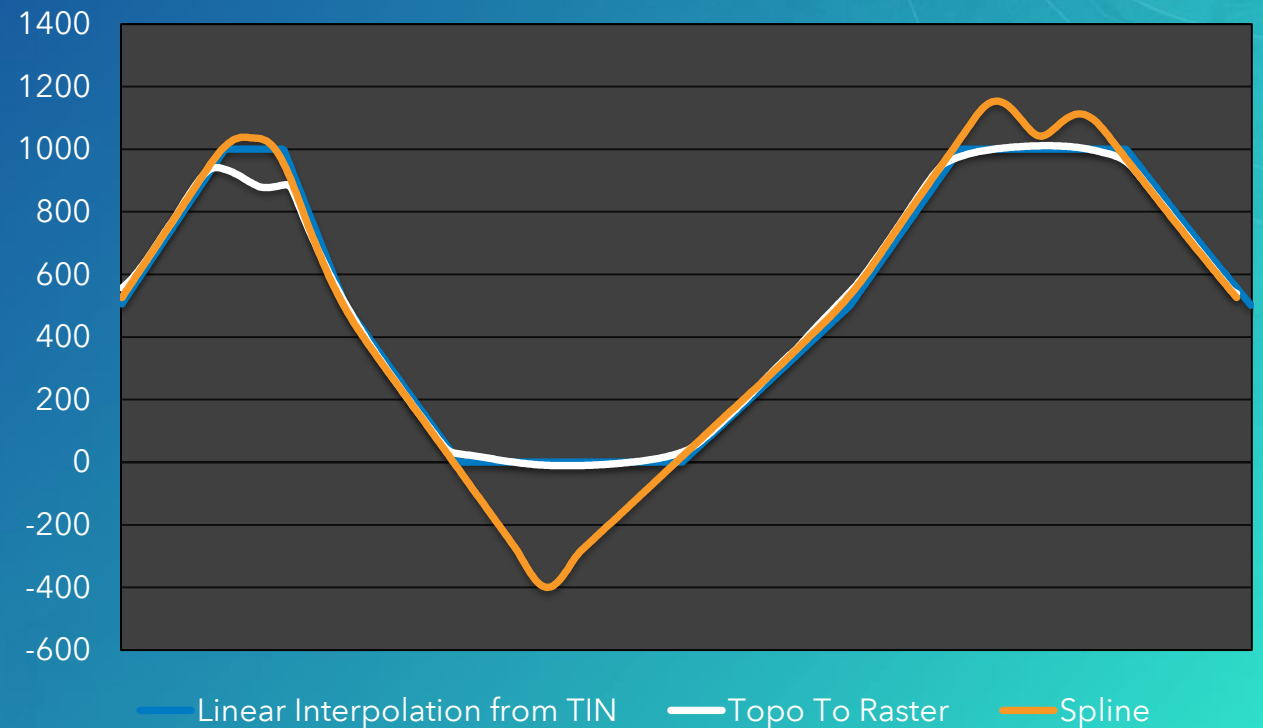


Grading Tool: Modify surface using line with slope properties.



Choosing the Most Appropriate Surface

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





Surface Analysis

Khalid Duri

Analysis Capabilities

Review of 3D Analyst Geoprocessing Tools



Exploratory Analysis 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.

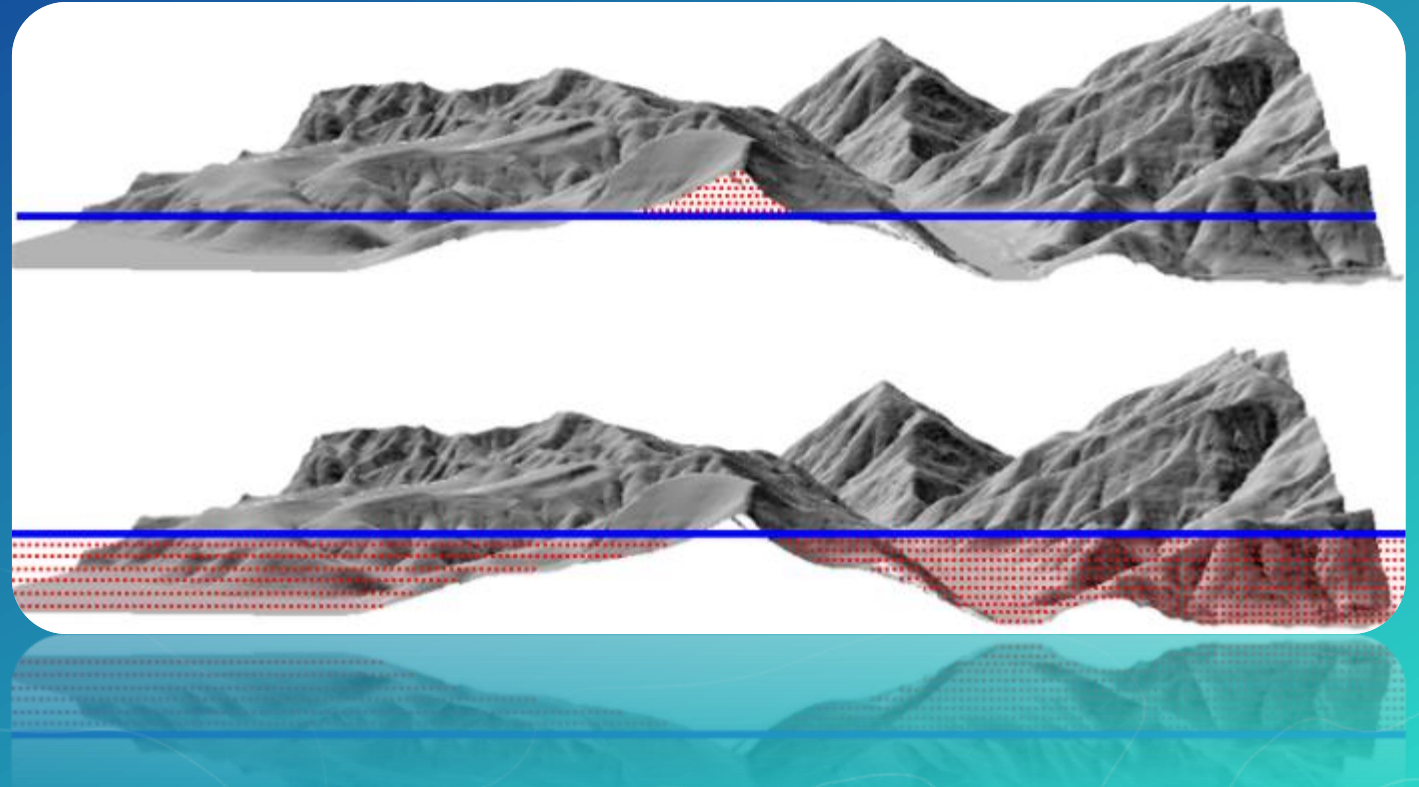
Contour: Creates a single isoline at the selected point.

Profile: Creates profile graph of surface or point cloud.

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

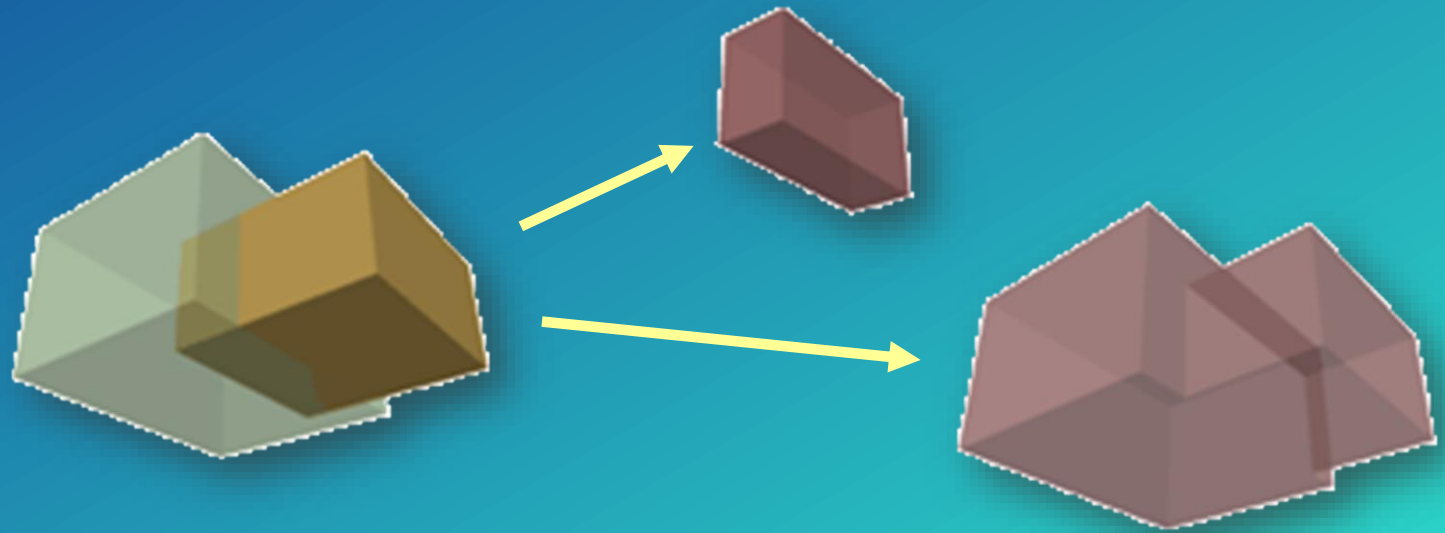
Spatial & Statistical Analysis

- Calculate slope
- Determine surface area & volume
- Find 3D length
- Regularize building footprints
- Create sealed enclosures

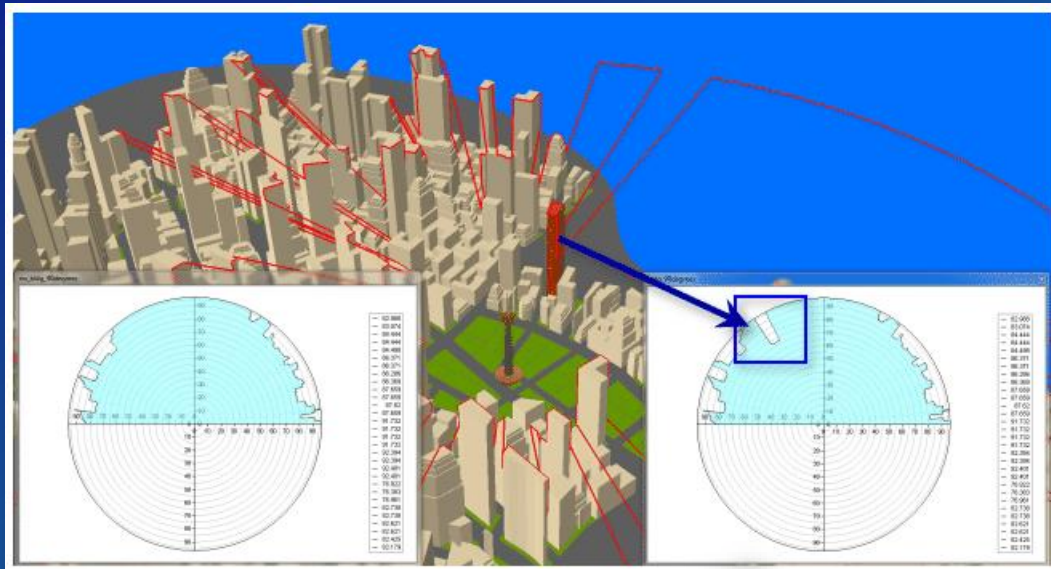


Overlay Analysis

- Find intersection of 3D lines, planes, and volumes
- Determine the difference between 3D features
- Find features that are contained by an enclosed geometry
- Merge intersecting features



Skyline Analysis



- Delineate the horizon
- Segment the horizon by contributing feature
- Graph the percent of obstructed sky

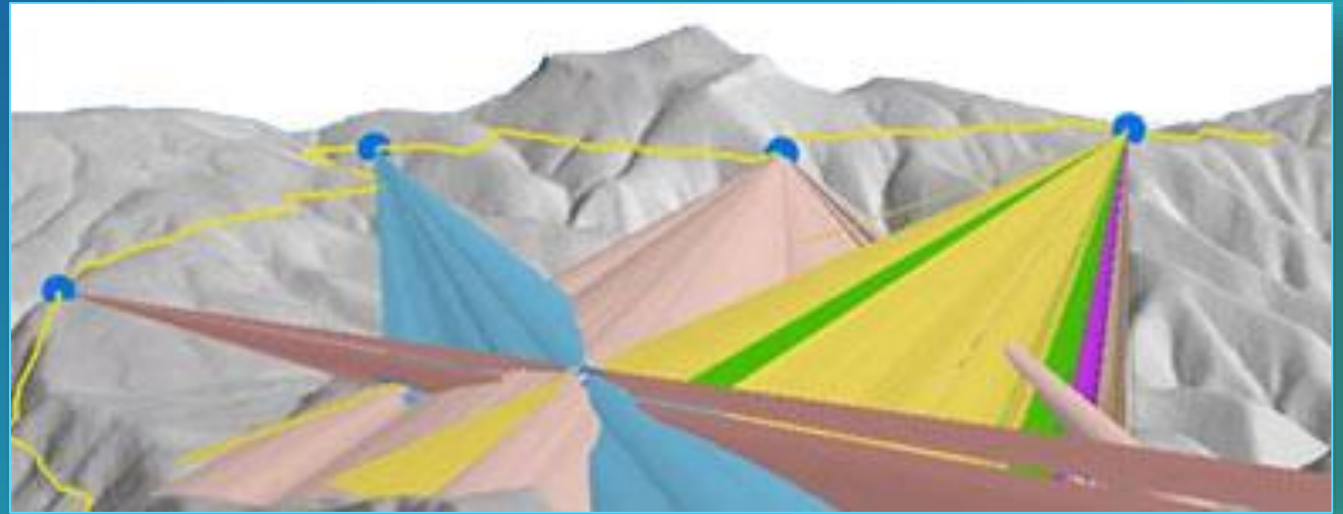
Sight Line Analysis

- Determine visibility along a line in true 3D space
- Identify points of obstructions
- Sight lines can be constructed from observer points and target features of any kind



Skyline Barrier

- Create closed volumes representing an observer's visible frustum
- Perform inside/outside tests using the resulting geometry
- Model shadows cast by localized light sources



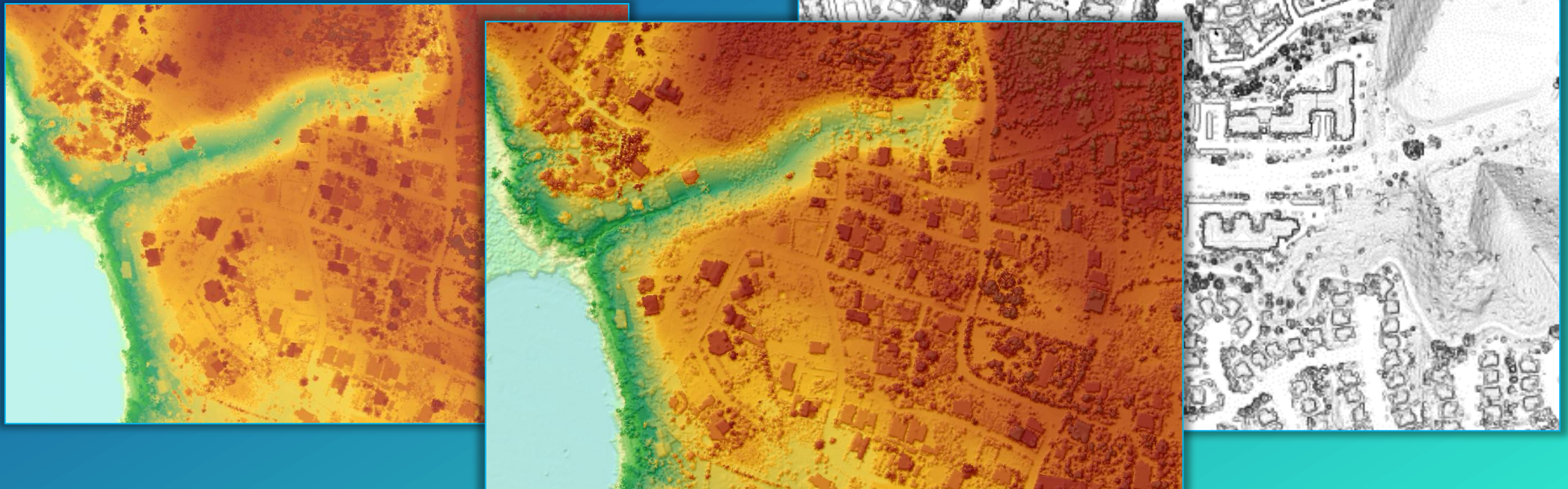
Sun Shadow Volume

- Determines shadows cast by 3D features
- Creates closed volumes that can be used in overlay analysis
 - Find what features intersect or are entirely contained by one or more shadows
 - Right-to-light studies
 - Urban heat island estimation



Hillshade

- Localized illumination from a fixed trajectory of light
- Provides 3D feel to a 2D map
- Can be used to create a “bone map” which offers a planimetric view that can identify features





Feature Analysis

Jinwu Ma

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