3D Analysis Tools in ArcGIS Pro

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GIS INSPIRING WHAT'S NEXT

Workshop Overview

- What's New in ArcGIS Pro
- Summary of 3D Analyst
- Overview of 3D Data Types
  - **3D Features**
  - **Surfaces**
- Overview of Analysis Capabilities
  - **LAS Support**
  - **Surface Analysis**
  - **Feature Analysis**
- Demos
  - **Change Detection**
  - **LAS Classification**
  - **Interactive Visibility**

What's New in 3D for ArcGIS Pro

- Scene layer enhancements
  - Integrated mesh support from OSGB
  - Editable point & 3D object scenes
  - ZLAS & LAZ support for point cloud
  - Optimized point cloud for vertically dense scans
- Geoprocessing Analysis
  - Colorize LAS
  - Fence Diagram
  - LAS Height Metrics
  - Regularize Adjacent Building Footprint
  - Various enhancements
- 3D display enhancements
  - Perspective & isometric display
  - Revit support
- Exploratory Analysis
  - Slice
  - Viewshed
  - Line of Sight
  - View Dome

Overview of 3D Data Types

Understanding Surfaces & 3D Geometry

Storing XYZ Information

Vector Geometry

Points | Lines| Polygon

Point Cloud

Mesh

Surface Model

Triangulated Irregular Network

Raster

Understanding the 3D Mesh

- Collection of points used to construct triangle faces that define true 3D data
- Rendering properties like textures, colors, and transparency
- Supported types:
  - Multipatch
  - Indexed 3D Scene Layer (I3S)
  - 3D Symbology

Constructing 3D Features

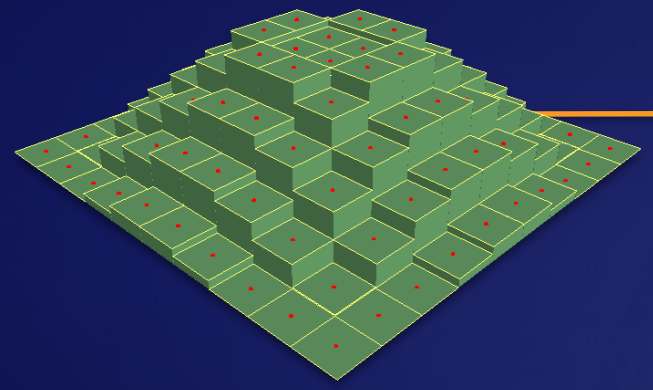
- Interactive edit session or custom code using ArcGIS SDK
- Symbolize points, lines, and polygons:
  - Procedural rules to create buildings from polygons, trees from points, etc…
  - Extrusion/base height properties to create walls from lines, volumes from polygons, and cylinders from points
  - 3D 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
  - OpenSceneGraphBinary (OSGB)
  - OpenFlight
  - VRML/GeoVRML
  - Wavefront OBJ *(Pro only)*
  - SketchUp *(Desktop only)*

Understanding the Surface

A representation of continuous data where one Z value exists for a given XY location.

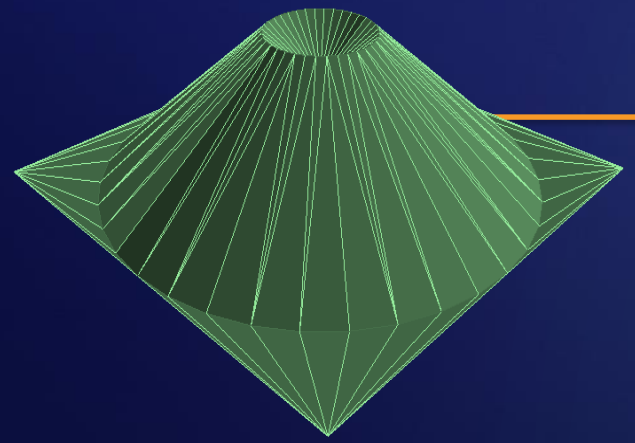
- **Temperature**
- **Gravitational fields**
- **Wind speeds**
- **Chemical concentrations**
- **Many diverse applications…**

Surface Data Models



Raster Surface

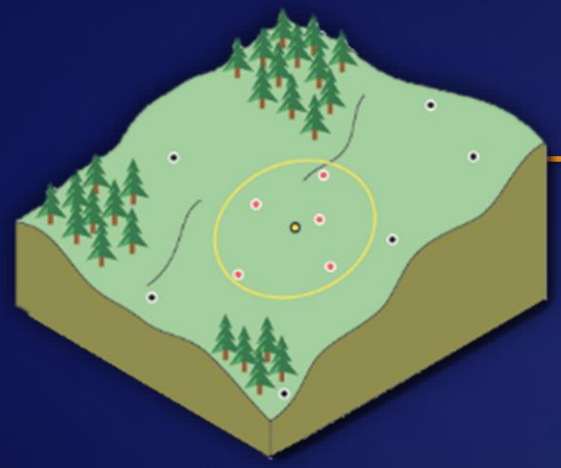
- Made by interpolation, generalize source measurements to cell size
- Fast to process, support robust math operations



TIN Based Surfaces

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

Distance Based Interpolation

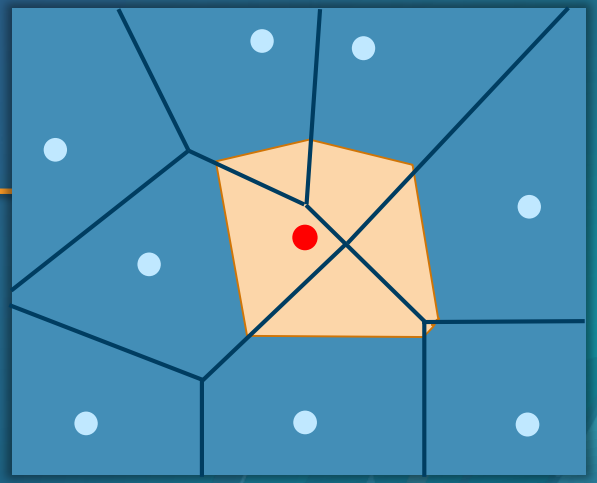


Inverse Distance Weighted (IDW)

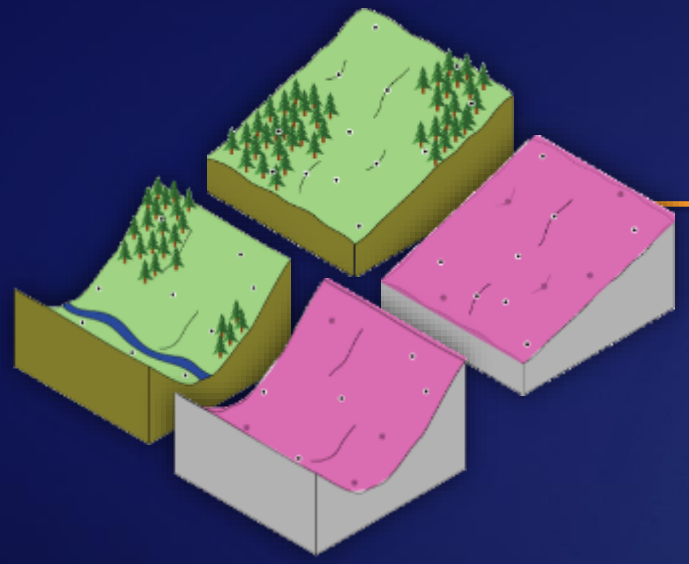
Consider using with evenly distributed source measurements that capture local surface variation.

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

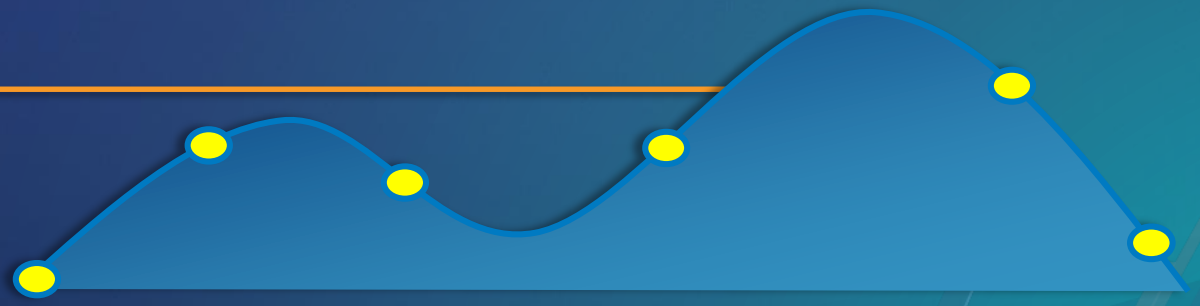


Trend

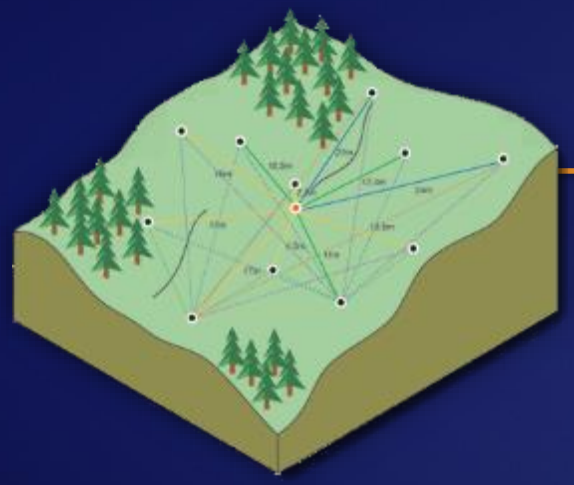
Useful for data with gradual variation (e.g. wind speed, temperature)

Spline

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

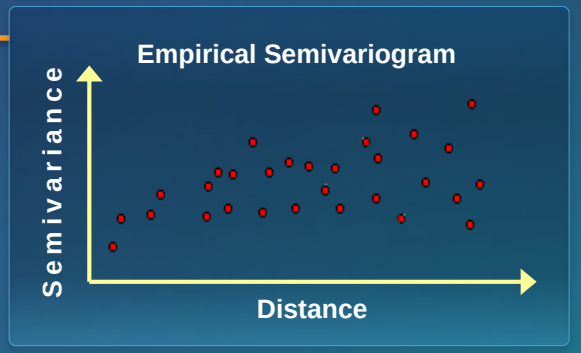


Kriging & Topo To Raster



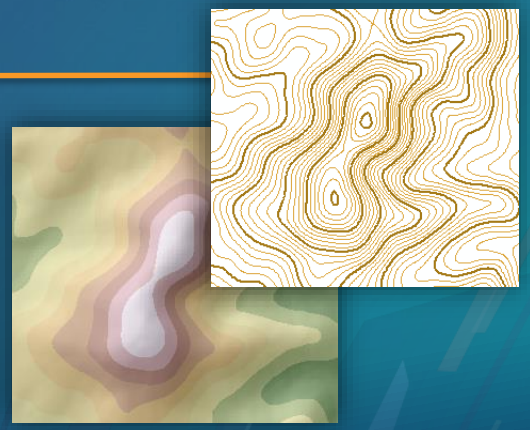
Kriging

Estimates a surface by assuming the distance or direction between the source measurements reflects a spatial autocorrelation that explains variations in the surface.

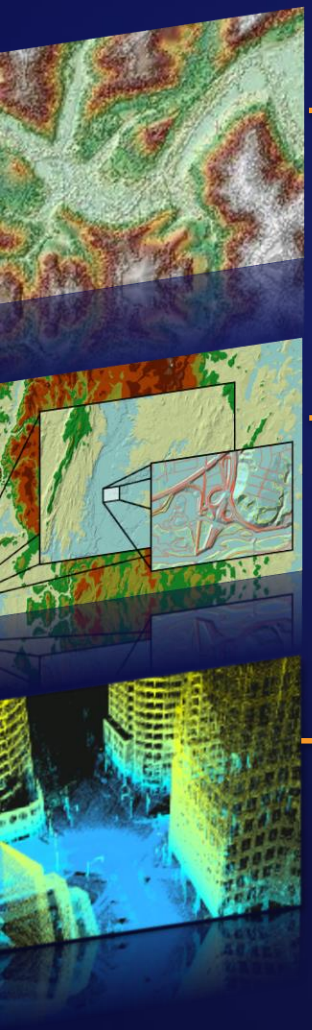


Topo To Raster

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



Triangulated Irregular Network (TIN) Surfaces



TIN

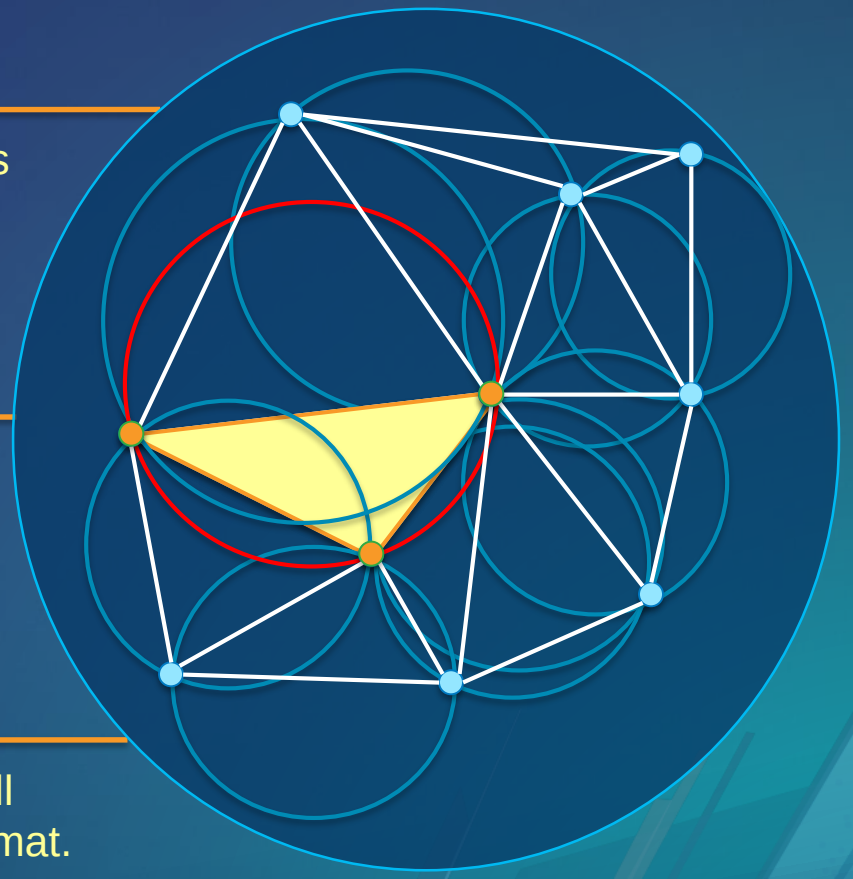
Well-suited for engineering applications and analysis of study areas that are not exceedingly large, provides interactive editing options.

Terrain

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

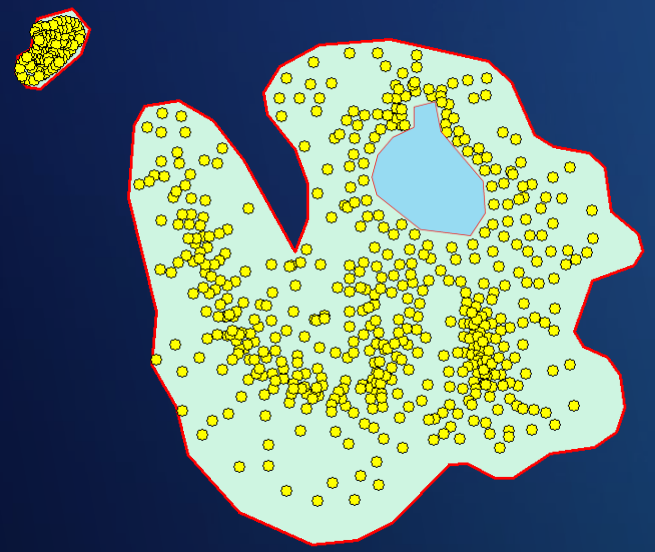
LAS Dataset

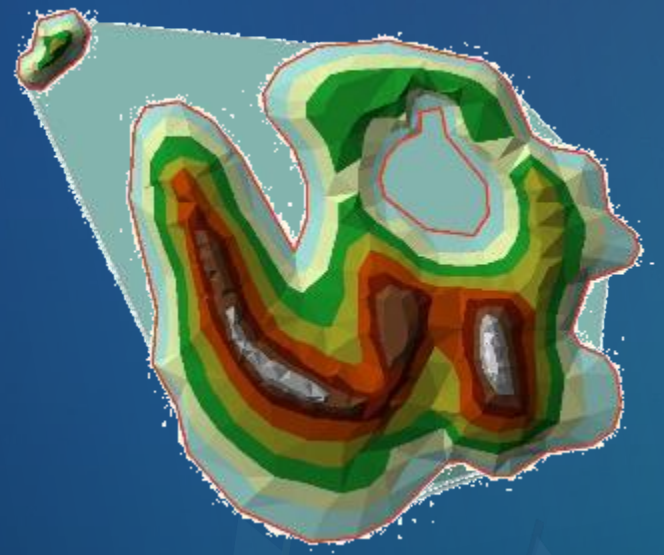
Rapidly visualize, filter, perform QA/QC and analyze lidar data. Well suited for aerial collections, supports compressed lidar in ZLAS format.



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

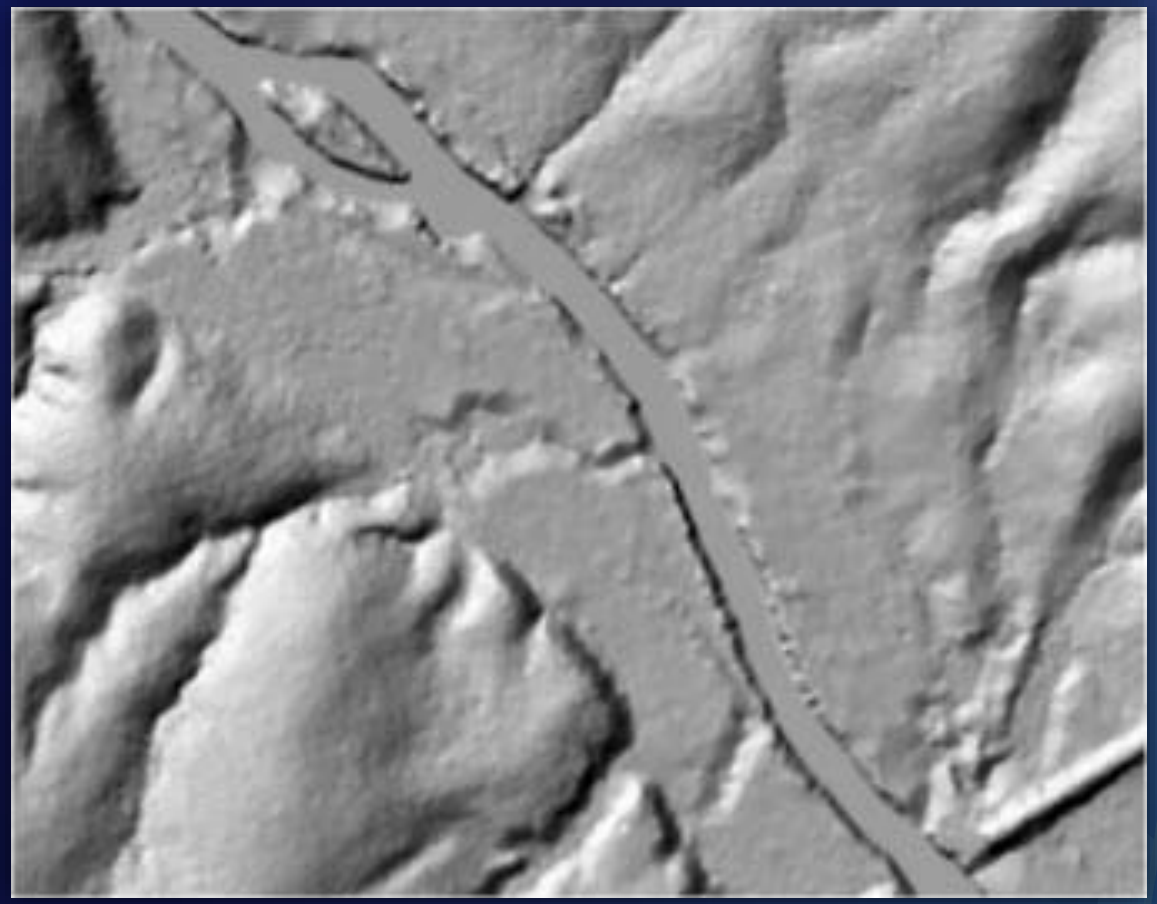


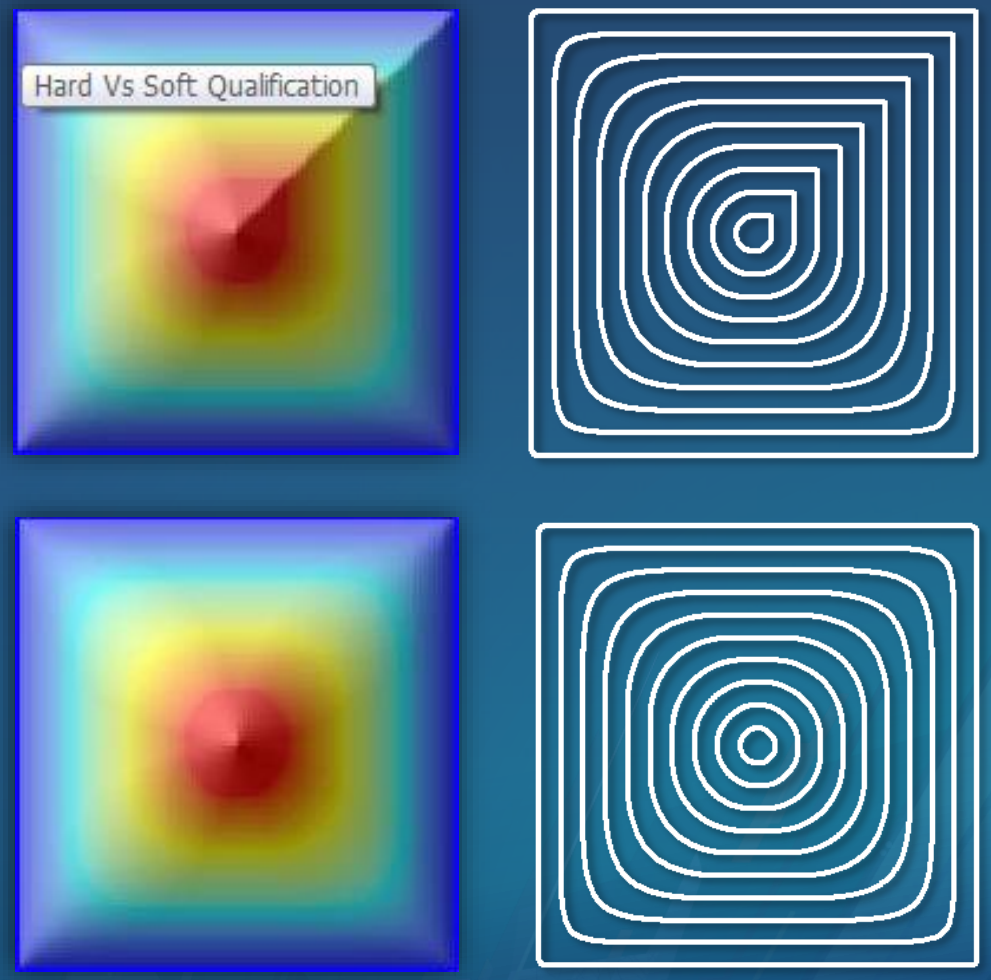


Also supports:

- Break lines
- Tag values

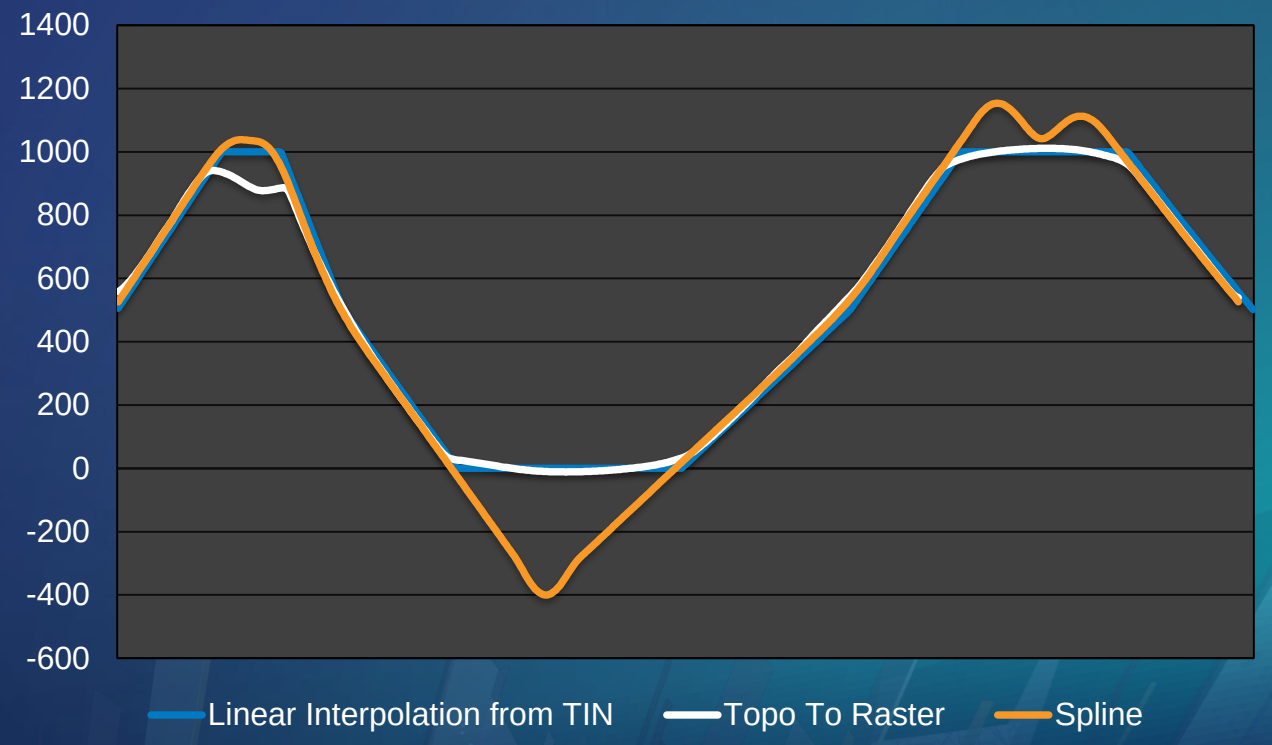
Hard vs. Soft Edge Types





Choosing the Appropriate Surface Model

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

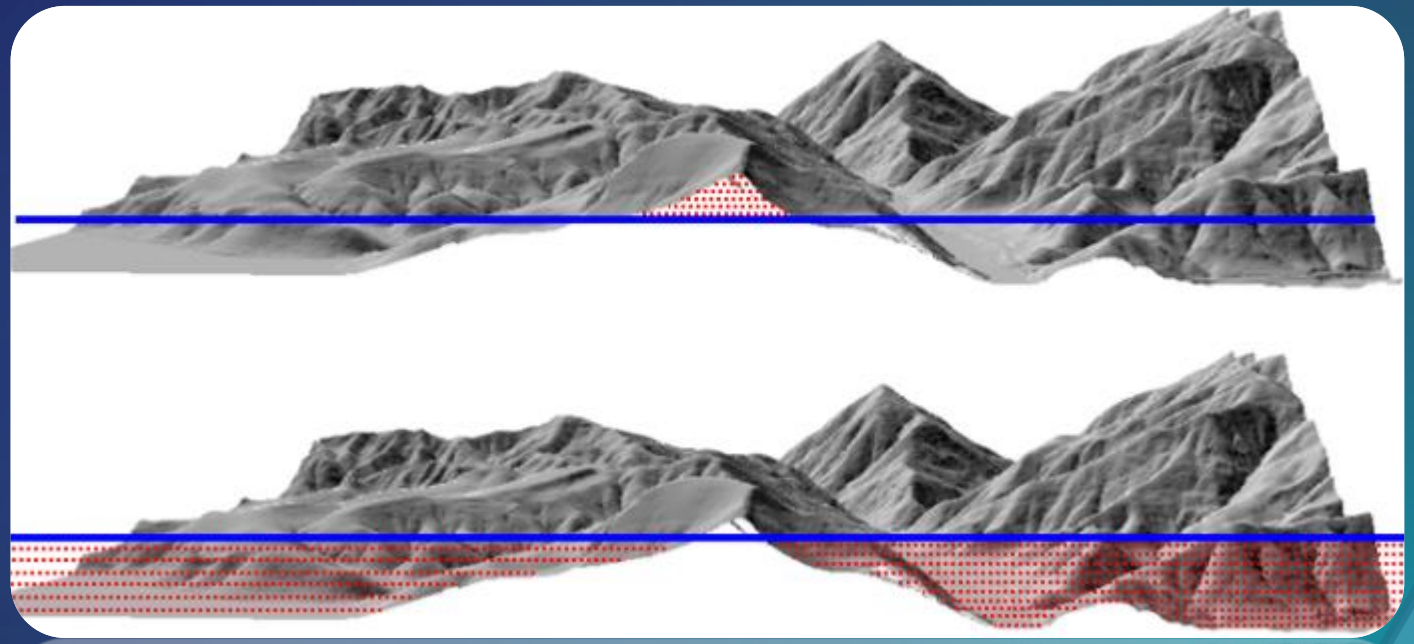


LAS & Surface Analysis

Classification | Spatial Statistics | Surface Derivatives

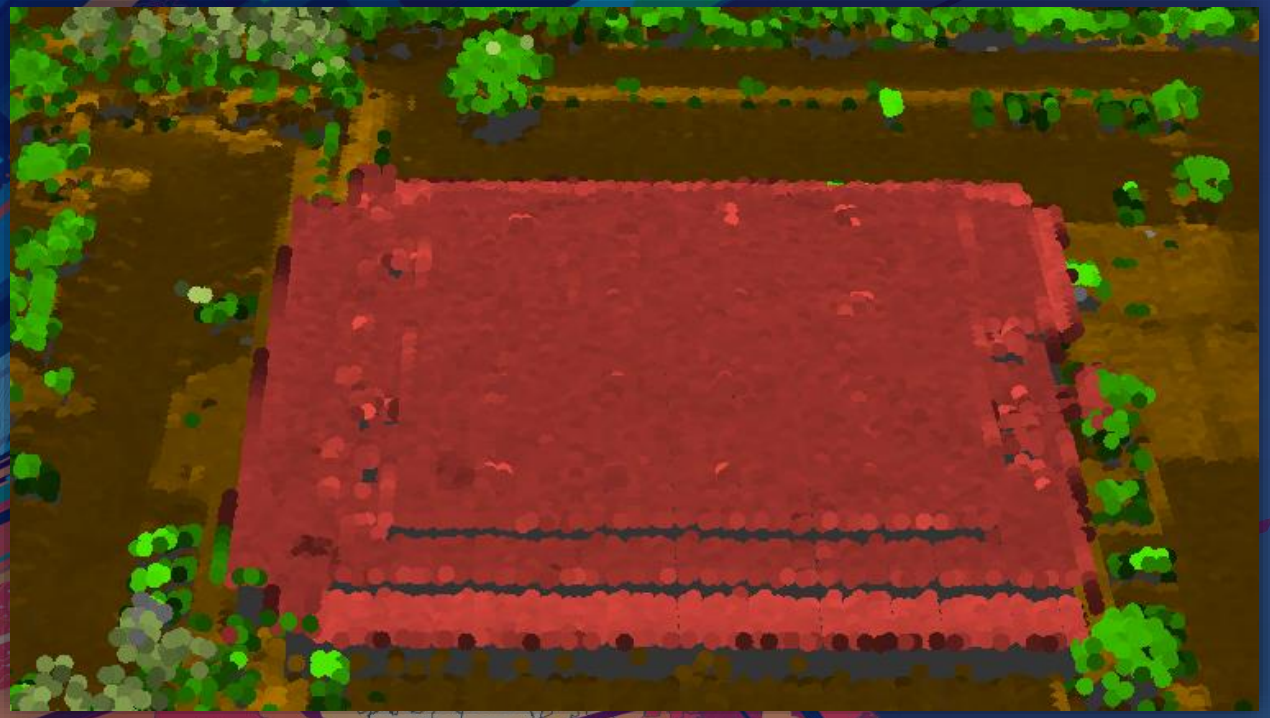
Surface Analysis

- Change detection
- Calculate area & volume
- Detect outlier measurements from ground
- Reclassify & perform math operations on raster datasets
- Produce derivatives
  - Slope
  - Aspect
  - Curvature
  - Contour Lines



LAS Support in ArcGIS

- Individual LAS/ZLAS files can be directly displayed and processed
- Multiple LAS/ZLAS files & surface constraint features can be viewed via LAS dataset
- ZLAS files save 30% of disk space but cannot be edited
- LAZ files can be displayed by importing to scene layer point cloud
- LAS points are dynamically thinned based on map scale
- LAS format supports designation of classification codes that can be used to identify discrete objects (buildings, roadway, ground, vegetation, bridge decks, etc…)
- Classification operations:
  - Ground
  - Building
  - Noise
  - Overlap scans
  - Height above ground
  - Interactive editing



Surface Analysis

LAS Classification & Change Detection

3D Feature Analysis

Overlay | Proximity | Visibility

Proximity Analysis

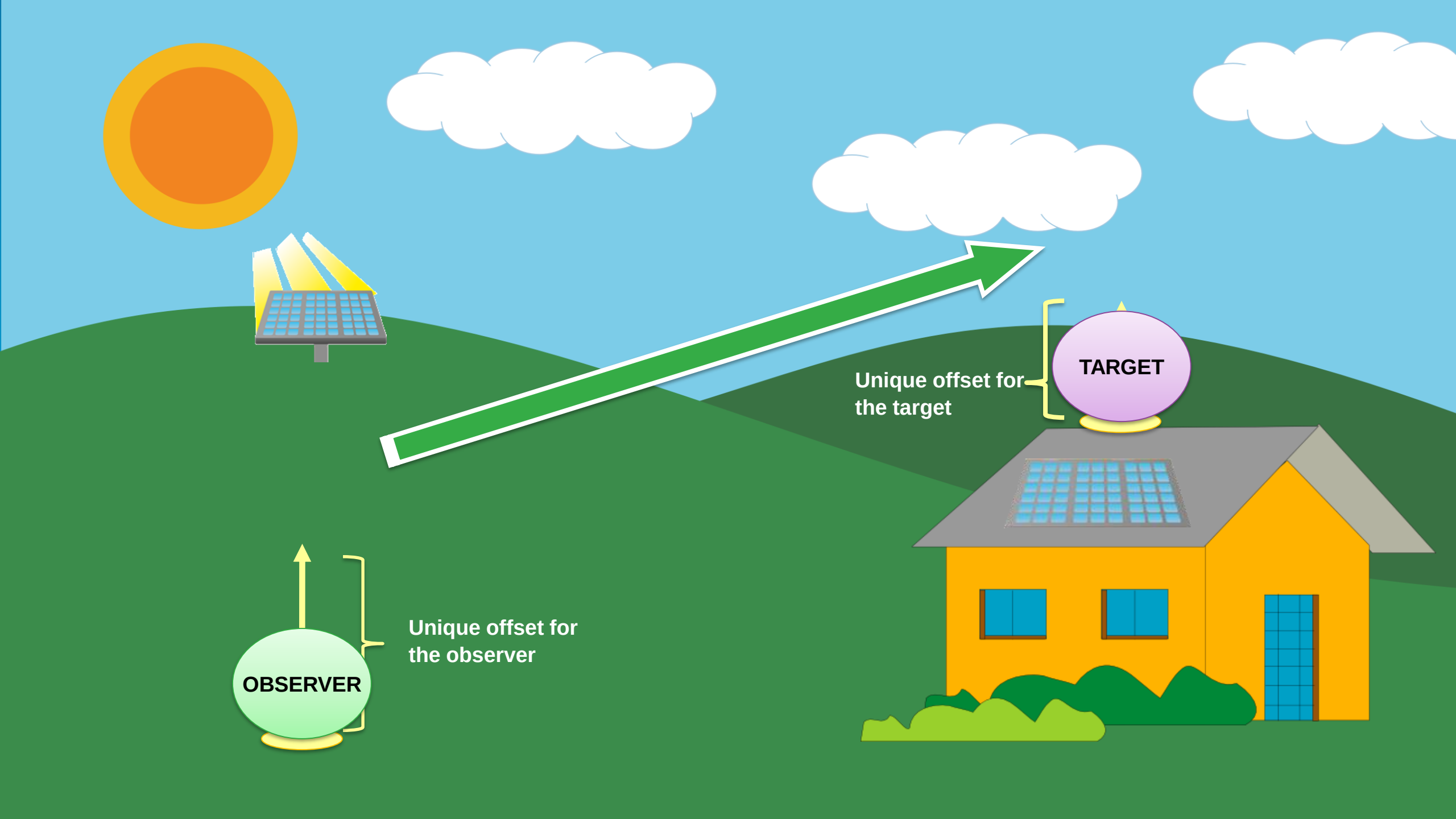
- Perform 3D buffers
- Identify closest objects in 3D Space
- Find intersection of 3D lines with surfaces/multipatch
- Construct the minimum bounding volume encompassing a cluster of points

Volumetric Overlay Analysis

- Determine if a 3D feature is a closed volume
- Identify features that reside inside volumetric features
- Perform set operator functions on closed volumes:
  - Difference between features
  - Overlap of feature
  - Union of features

Visibility Analysis

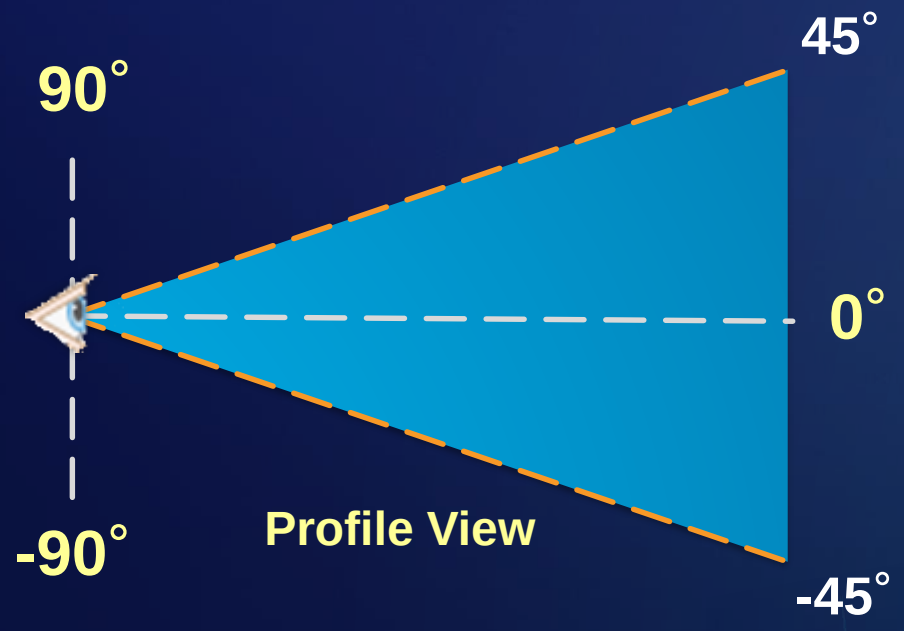
Overlay | Proximity | Visibility

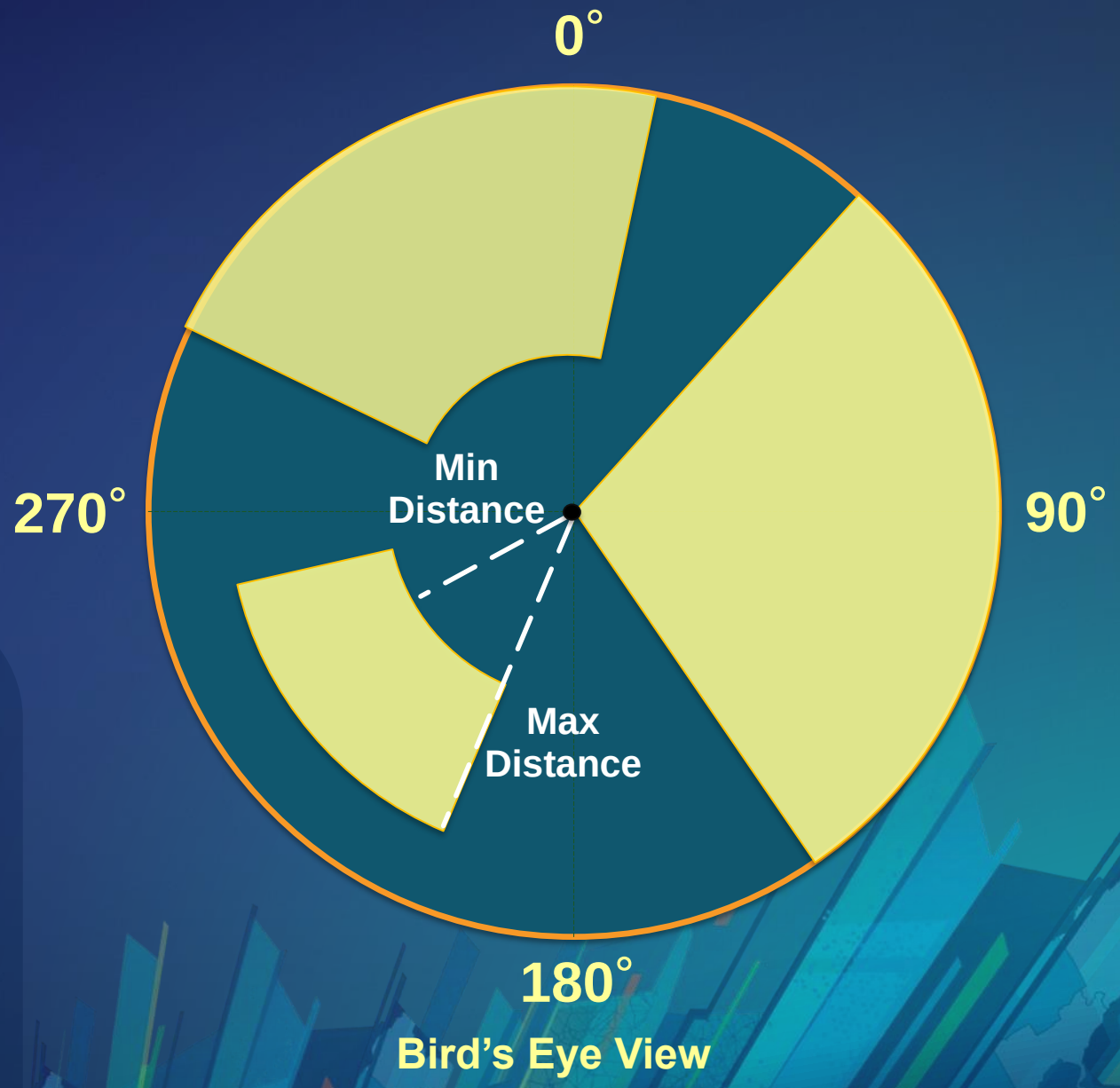

TARGET
Unique offset for the target
OBSERVER
Unique offset for the observer

Controlling the Observer

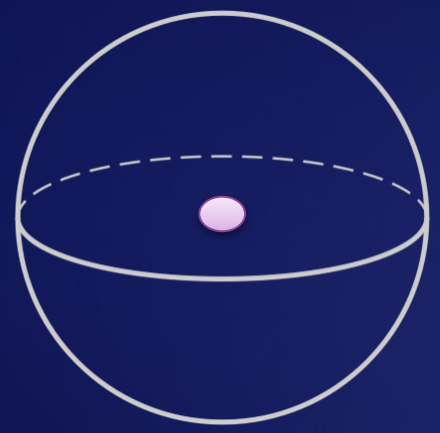
Viewshed frustum defined by:

- Azimuth and vertical angle range
- Visibile distance range
- Observer and target offset





Examples of Observer Profiles

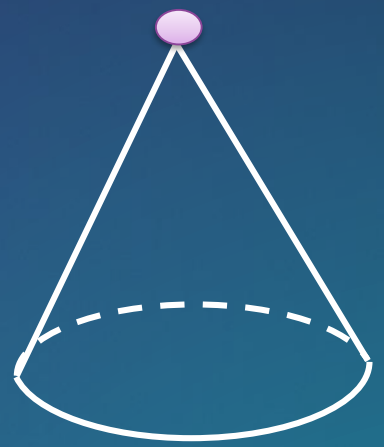


Spherical Observer

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

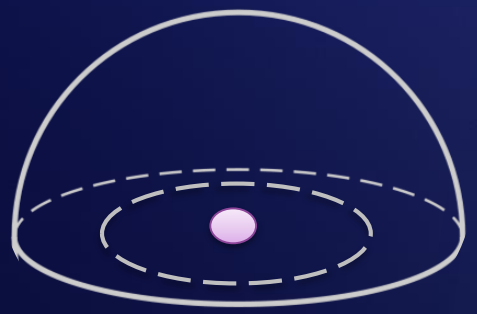
Conical Observer

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



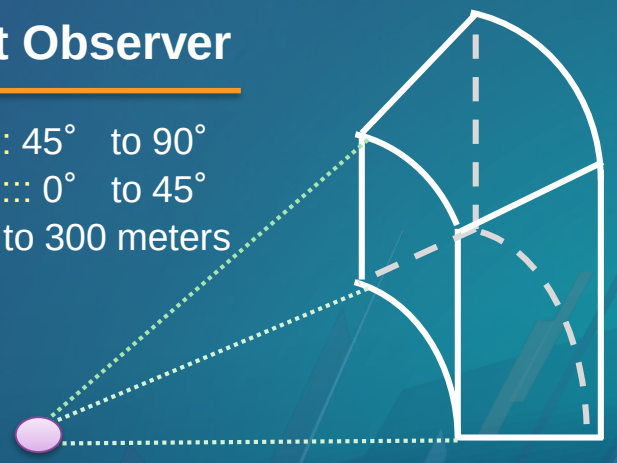
Hemispherical Observer

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



Distance Offset Observer

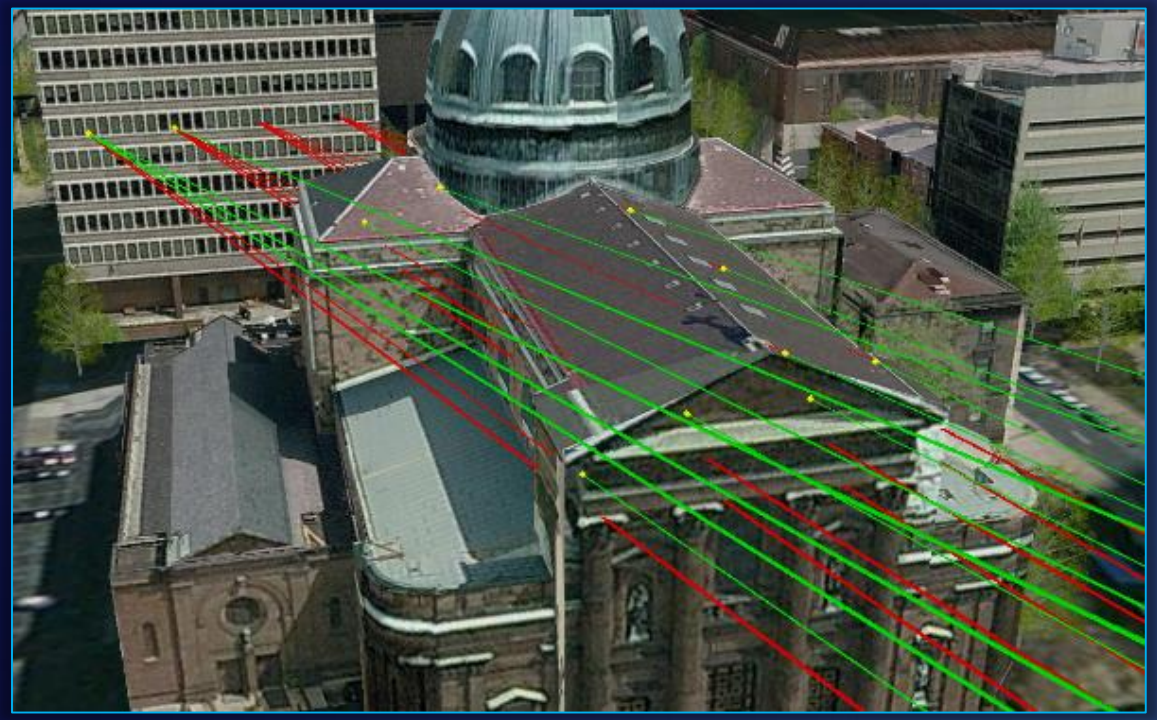
Azimuth ::: 45˚ to 90˚
Vertical Angle ::: 0˚ to 45˚
Distance ::: 250 to 300 meters



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

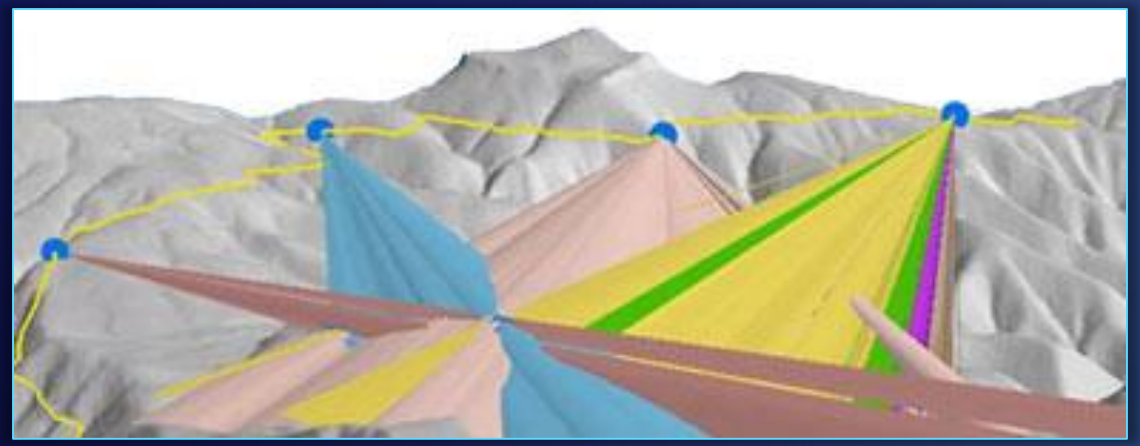
Sight Line Analysis

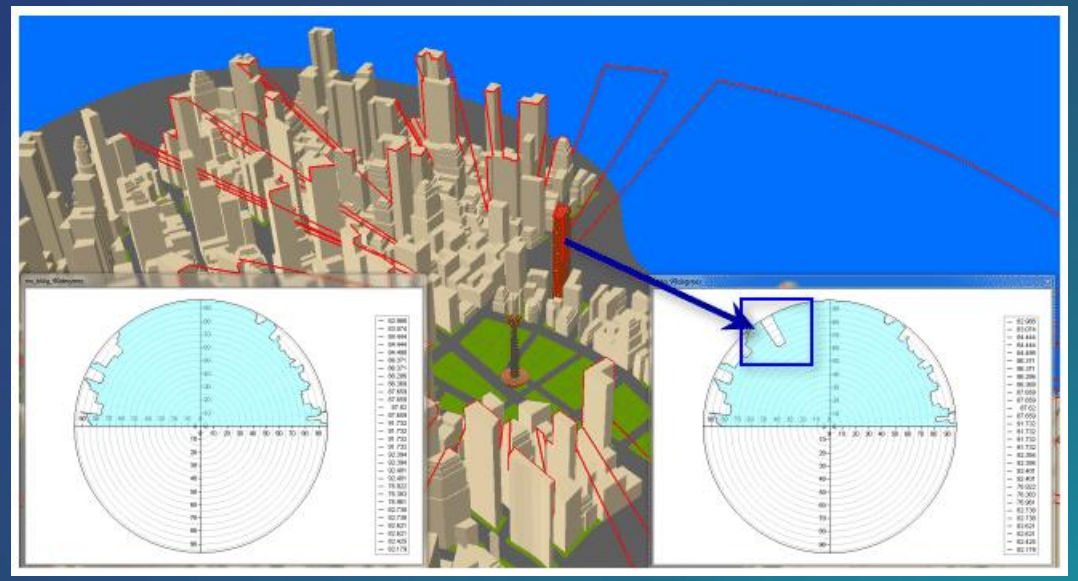


- Determine visibility along a 2-vertex line in true 3D space
- Identify the first point that obstructs a non-visible target
- Interactively generate a sightline and manipulate the scene, observer and target positions to dynamically explore multiple scenarios

Skyline Analysis

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



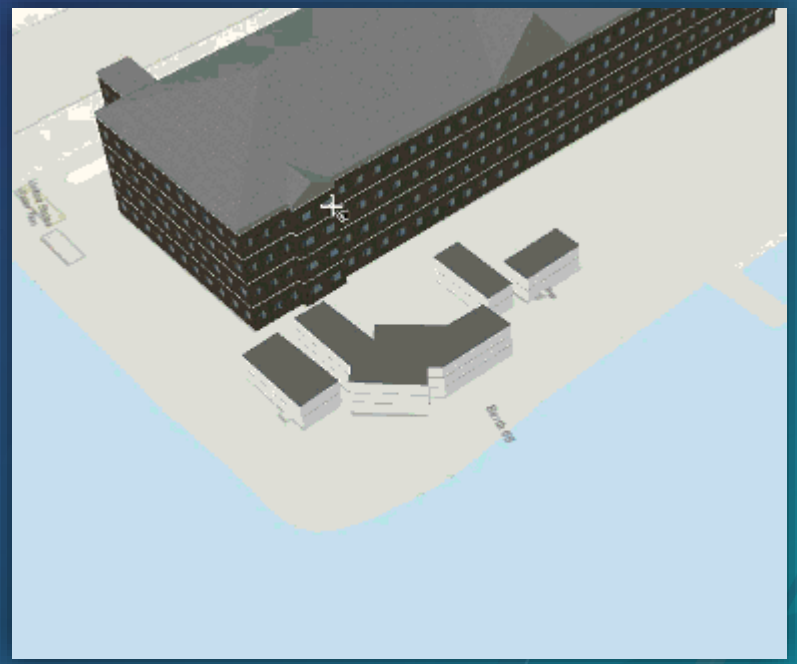


Sun Shadow Analysis

- Determines where shadows cast by 3D features land on a surface
- Create closed volumes that can be used to determine the overlapping presence of objects in shaded spaces
  - Right-to-light studies
  - Urban heat island estimation

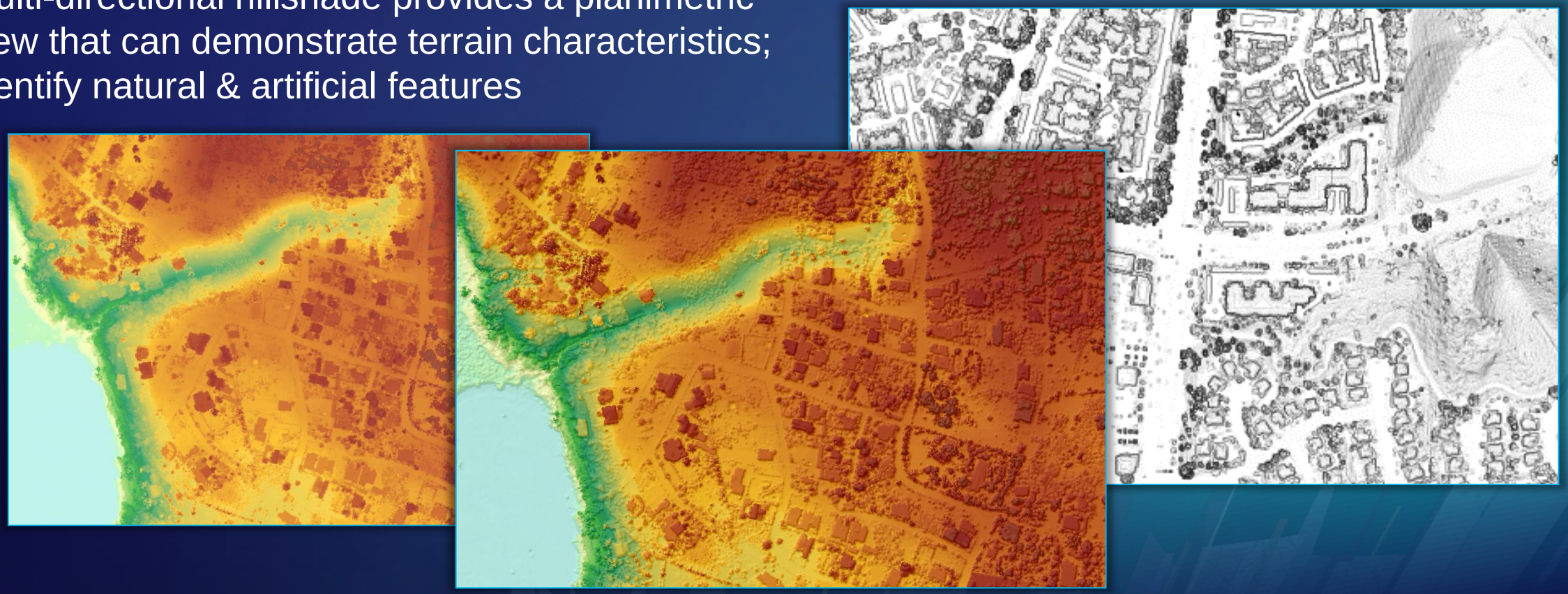
Viewshed

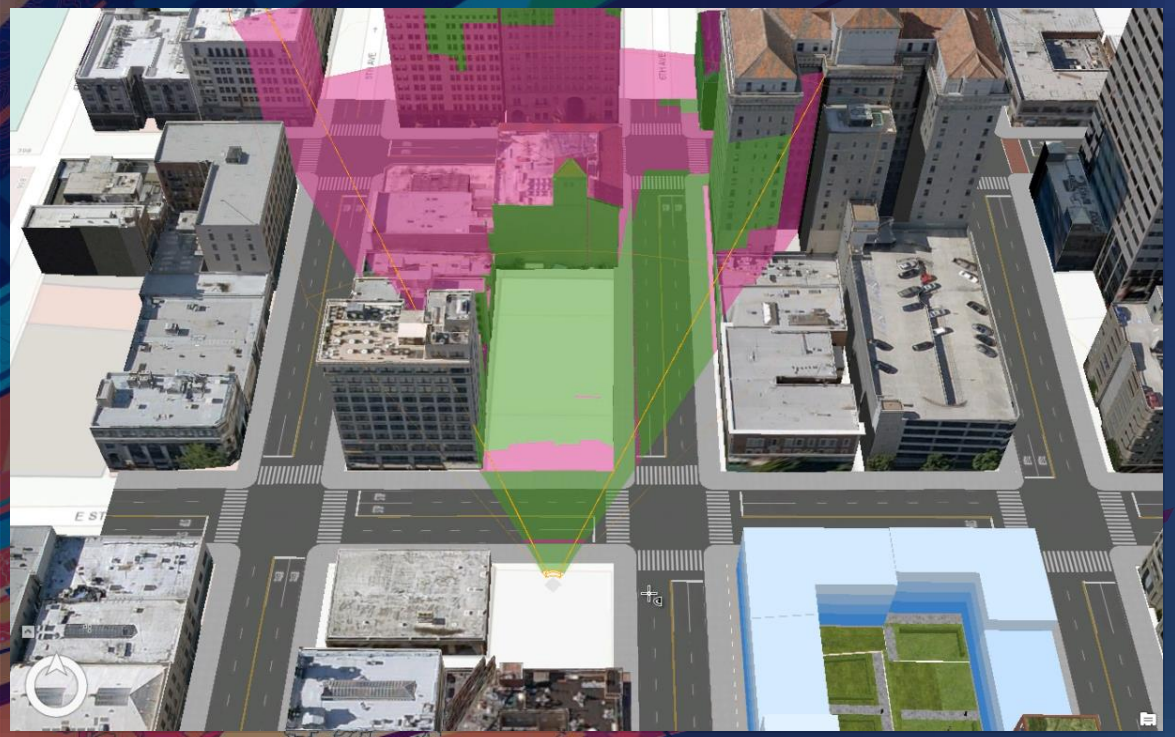
- Identifies what can be seen from an observer for a vast tract of space
- Automated viewshed supports target offset
- Interactive viewshed supports real-time updates



Hillshade

- Localized illumination from a fixed trajectory of light or from multiple directions that accentuate sharp features
- Multi-directional hillshade provides a planimetric view that can demonstrate terrain characteristics; identify natural & artificial features





Visibility Analysis

Using Exploratory Tools

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