3D Feature & Sub-Surface Analysis

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Workshop Outline

- What’s New
- 3D Data Types
- Sub-Surface Analysis
- Examples
- Q & A

Workshop Overview

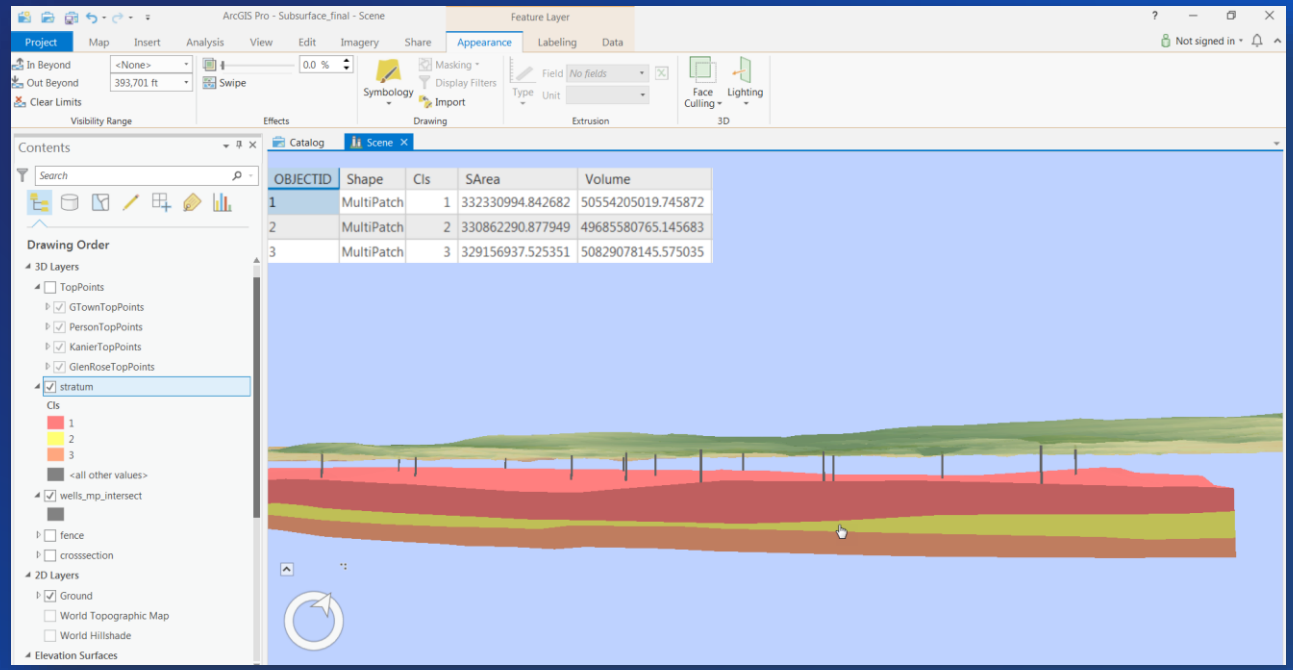
- What’s New
- 3D Data Models
- Sub-Surface Analysis
- Examples
- Q & A

What’s New in ArcGIS Pro

- 3D interpolation with Empirical Bayesian Kriging 3D (EBK3D) [2.3]
- Generate reports from statistical aggregations [2.3]
- Enhanced shading to emphasize depth characteristics of 3D data [2.4]
- Easily add multiple surfaces as separate elevation sources [2.4]
- Generate a profile view to interactively examine a 3D cross section [2.4]
- Interactively edit raster elevation data with the Pixel Editor [2.4]
- Interactively assess the cut-fill needed to level an elevation surface [2.4]

Subsurface GIS

- **Construct 3D models**
  - Interpolate surfaces
  - Construct fence diagrams & volumetric shells of geologic strata
  - Visualize infrastructure assets
- **Analyze spatial properties**
  - Compute volume & area
  - Find intersection of wells, tunnels, & boreholes with geologic strata
- **Communicate results**
  - Create charts & reports
  - Share on multiple platforms



Modeling in 3D Space

Overview of Data Types

Storing XYZ Information

Vector Geometry

Points | Lines| Polygon

Point Cloud

Mesh

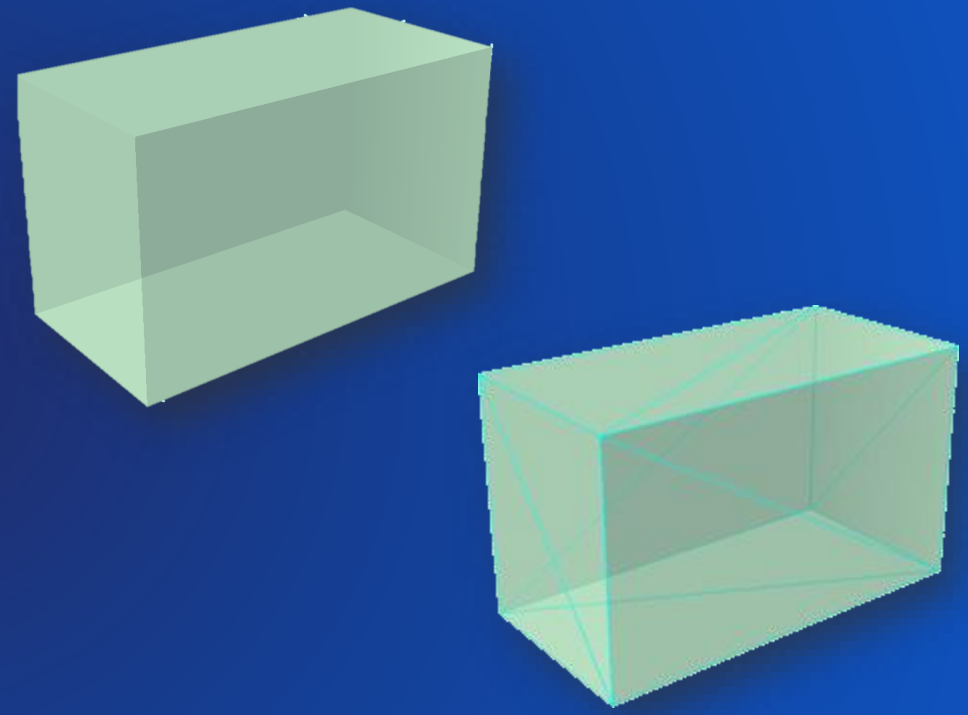
Surface Model

Triangulated Irregular Network

Raster

Understanding Mesh Geometry

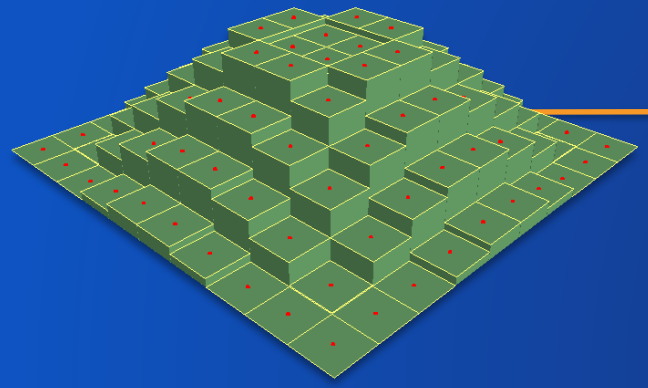
- **Collection of triangles**
- **Support textures, colors, and transparency**
- **Represent many types of data:**
  - Discrete objects
  - Outer shell of a volume
  - Continuous measurements
    - Terrain with overhangs and enclosed spaces
    - Isosurface with multiple Z values at an XY



Constructing 3D Features

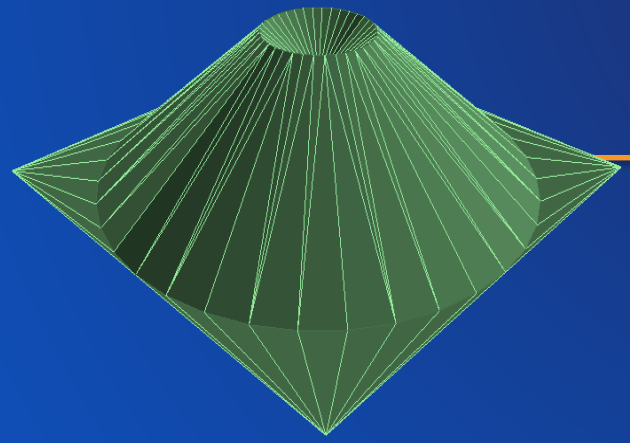
- Interactive digitization
- Symbolize points, lines and polygons:
  - Procedural rules to create complex models driven by feature attributes
  - Extrusion/base height properties to create walls from lines, volumes from polygons, and cylinders from points
  - Standard 3D marker symbols for points, tube 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)*

Surface Data Models



Raster Surface

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



TIN Based Surfaces

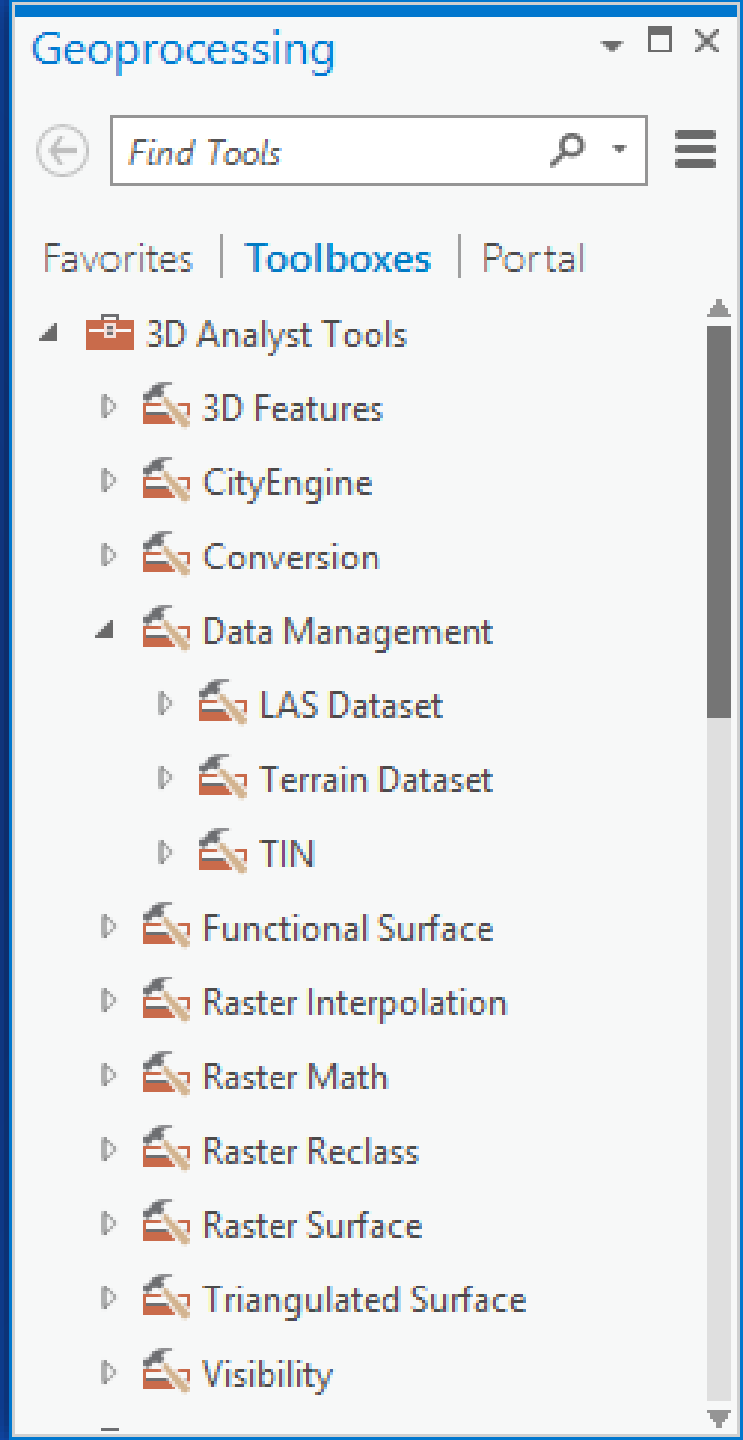
- Created by triangulation, maintain source measurements
- Support robust surface definitions & data

Analysis & Data Management

Working with Sub-surface Data

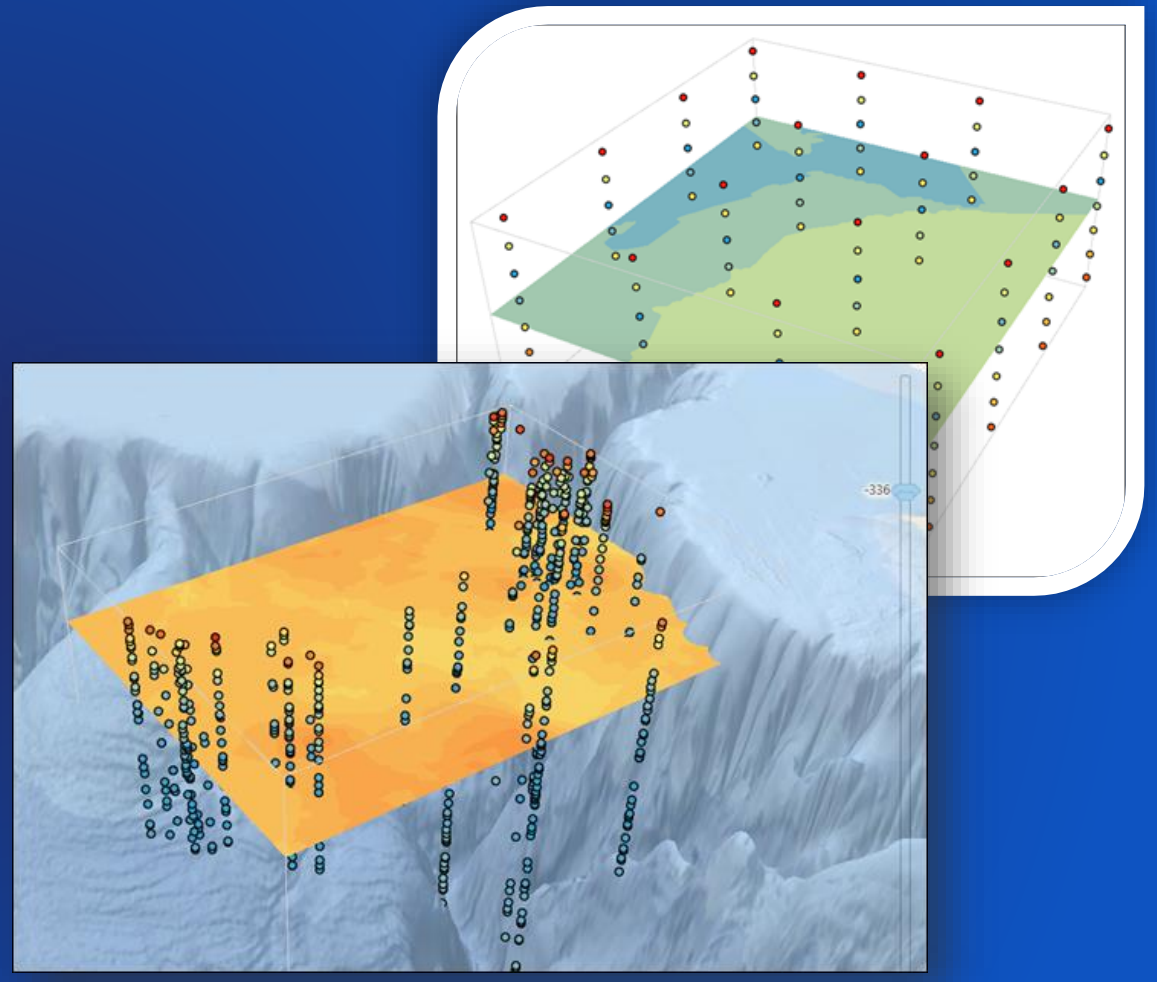
Analysis Framework

- **Geoprocessing capabilities**
  - Analysis
  - Data conversion
  - Data management
- **Exploratory analysis**
  - Empirical Bayesian Kriging (EBK) + EBK3D
  - Visibility tools (viewshed, line of sight)
  - Profile view
- **Automate workflows**



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



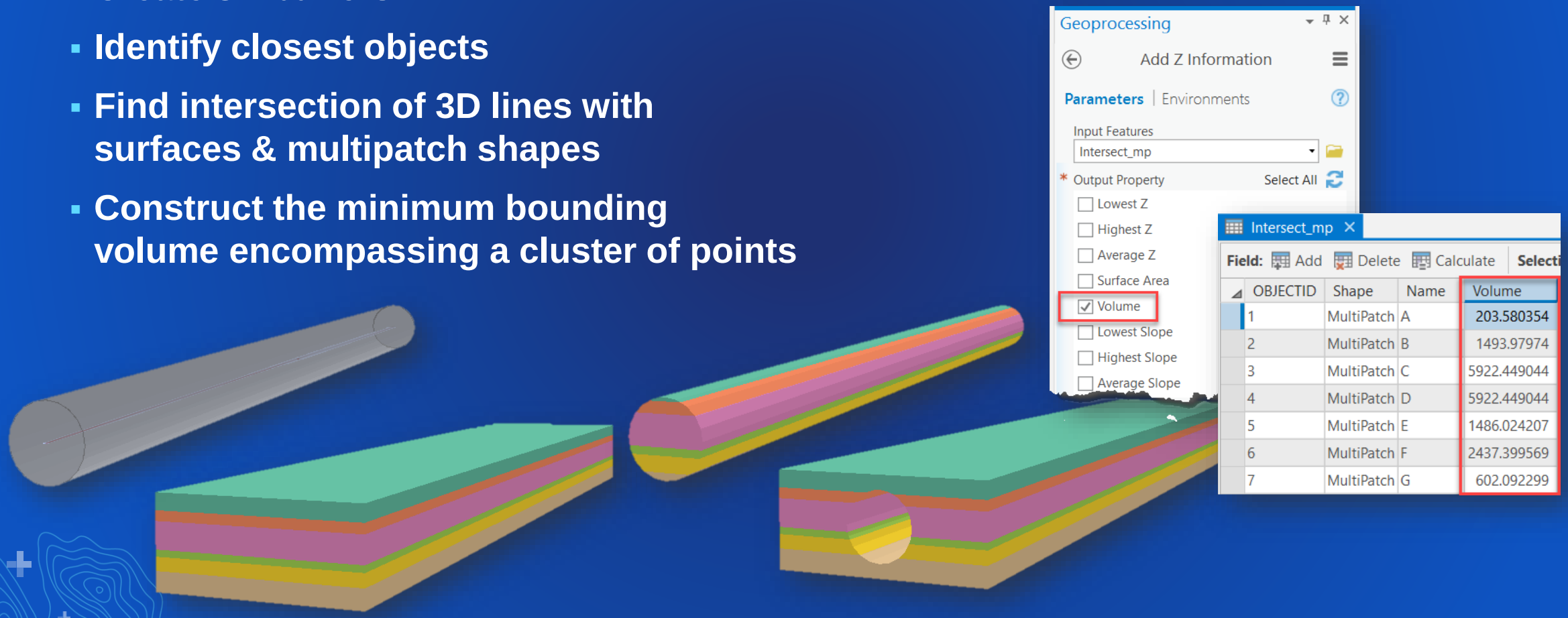
Using Living Atlas Data & ArcGIS Pro for 3D Interpolation, Thursday 2:30, Room 30C
Kriging: An Introduction to Concepts and Applications, Thursday 4:00, Room 15B

Elevation Surfaces

- **Add each subsurface strata as its own elevation surface**
- **Apply lighting to accentuate slope characteristics**
- **Cached for optimal display experience**
- **Can be sourced from:**
  - Raster
  - TIN
  - Web elevation layer from ArcGIS Portal
  - Elevation service from ArcGIS Server

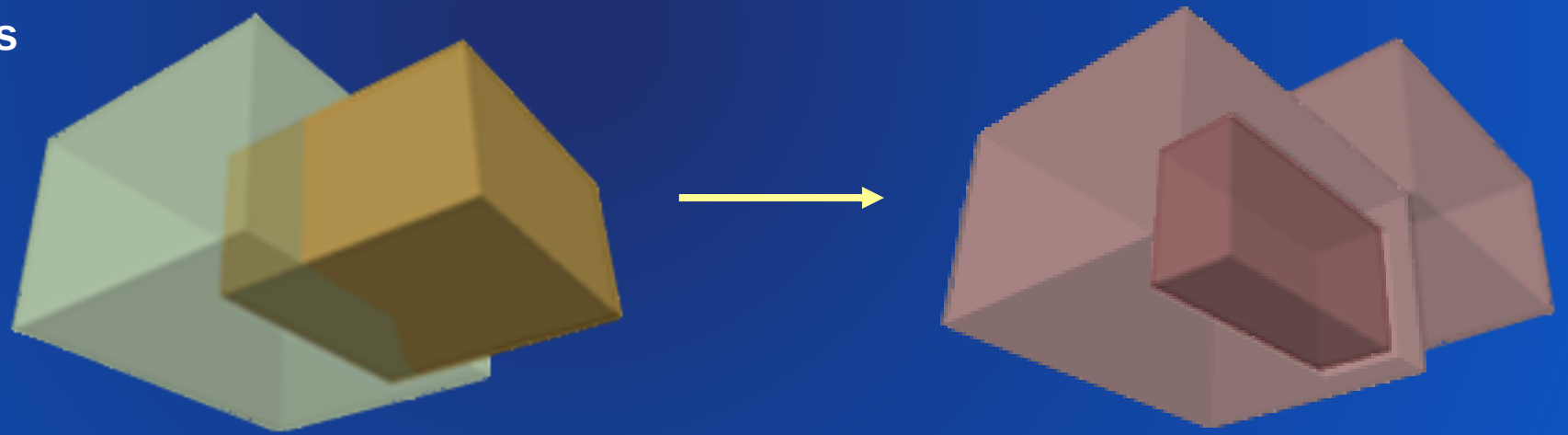
Proximity Analysis

- 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 enclosures
- Perform geometric operations:
  - Difference between volumes
  - Overlap of volumes
  - Union of volumes



Sub-Surface Analysis Workflow

Model

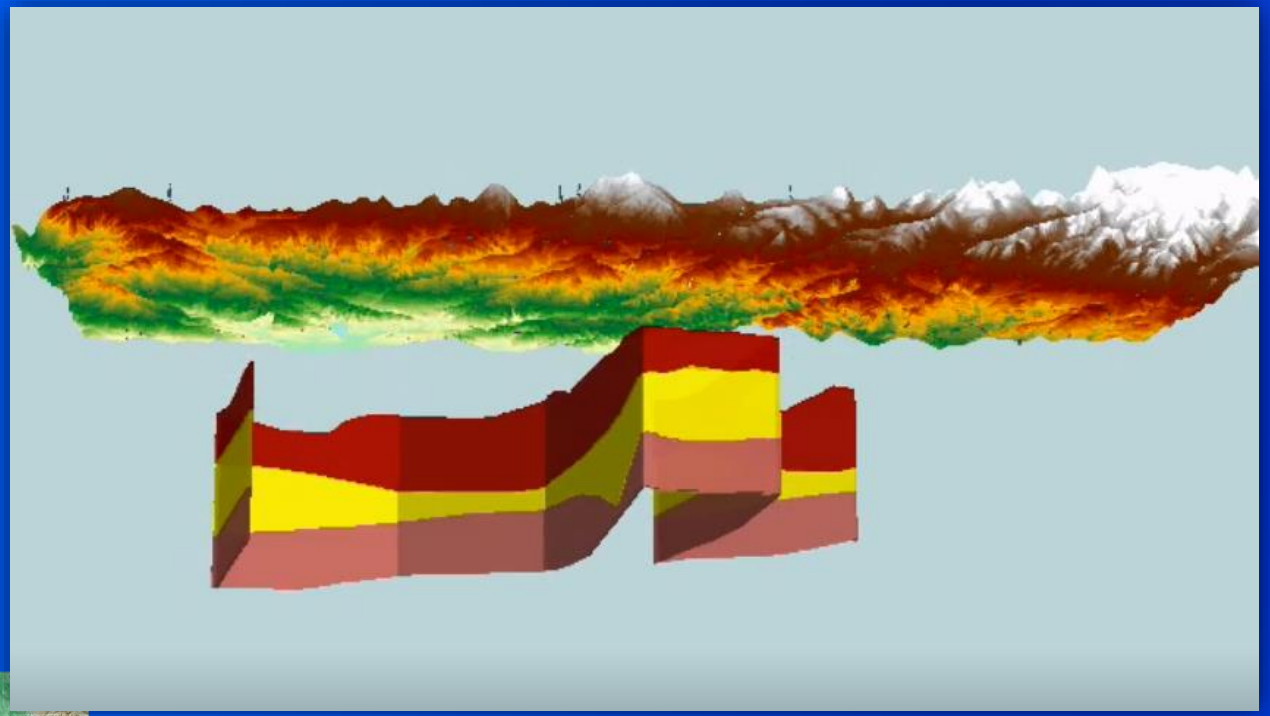
- Interpolate surfaces
- Construct 3D features
- Symbolize data

Analyze

- Visual analysis
- Spatial analysis
- Create charts

Share

- Printed maps
- Digital static maps
- Interactive online maps



Model Geological Structures

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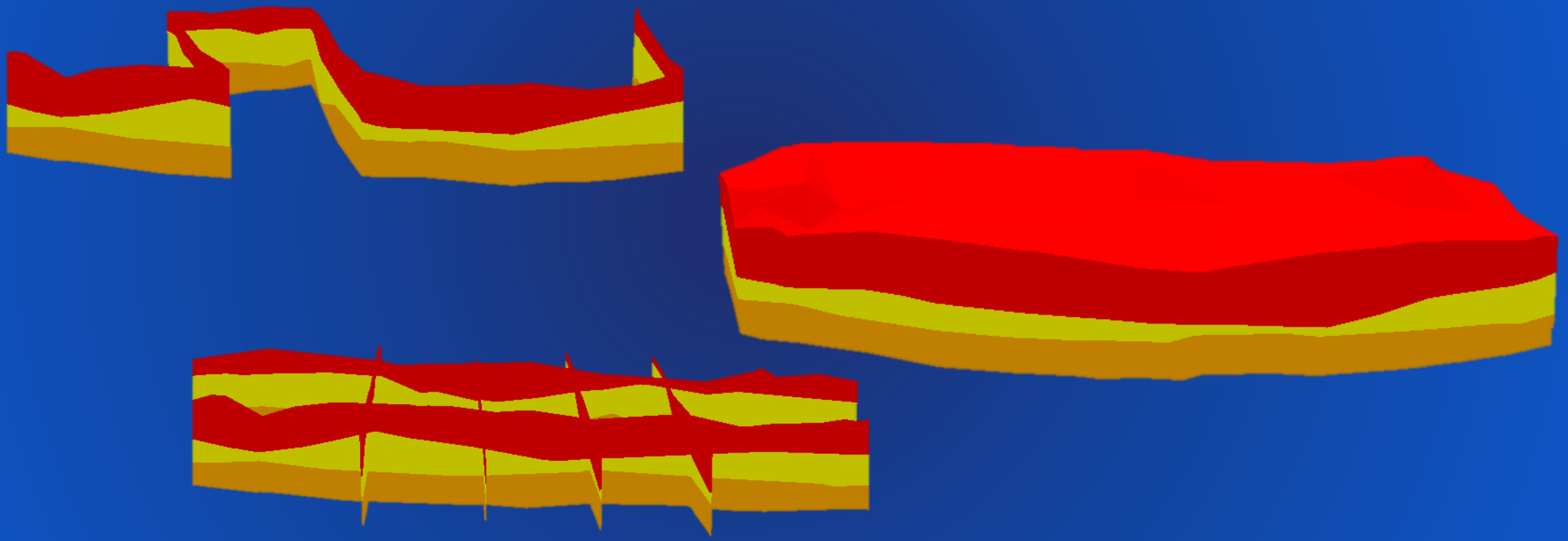
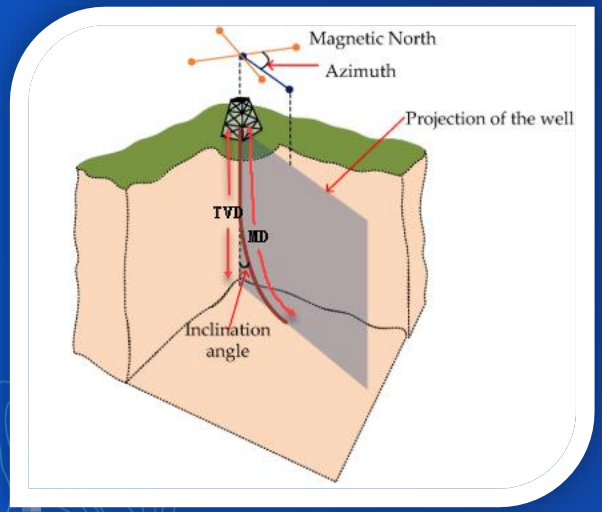
Construct Strata & Fence Diagrams



Model Direction Wells

- **Custom sample to convert ASCII records to line features from survey measurements:**
  - Measured depth (MD)
  - True vertical depth (TVD)
  - Inclination
  - Azimuth



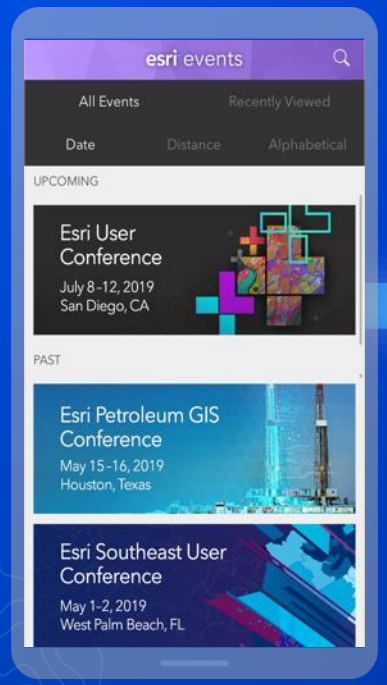

```
import arcpy
import os

filePath = r"C:\Shared\Subsurface\UC2018\DirectionalSurvey.txt"

file = open(filePath, "r")

lateralfc = r"C:\Shared\Subsurface\UC2018\Data.gdb\Lateral"

XStart = 2114464.393702
YStart = 10315414.494273

array = arcpy.Array()
point = arcpy.Point()

for line in file:
    M, Z, NS, EW = line.split()
    point.Z = float(Z) * -1
    point.X = XStart + float(EW)
    point.Y = YStart + float(NS)
    point.M = float(M)
    array.add(point)
```

Measured Depth (ft)	Incl (deg)	Drift Dir (deg.)	TVD (ft)	Course Length (ft)	Vertical Section (ft)	TOTAL Rectangular Offsets (ft)	(ft)	Closure Dist (ft)	Dir. (deg.)	DLS (dg/100ft)
TIED INTO DDC GYRO SURVEY @ 11,106' MD.										
11106.00	0 60	272 90	11105.00	0.00	-51 57	51.70 N	9.00W	52.48	@350.12	0.00
THE FOLLOWING ARE PATHFINDER MWD SURVEYS.										
11215.00	0.35	281.00	11214.00	109.00	-51.65	51.79 N	9.90W	52.73	@349 18	0.24
11246.00	0.53	255.25	11245.00	31.00	-51 63	51.77 N	10.13W	52 76	@348.93	0.85
11278 00	6.10	181 33	11276.93	32.00	-49 89	50.03 N	10.31W	51.09	@348.36	18.67
11309 00	15.04	178 61	11307.38	31.00	-44.21	44 36 N	10 25W	45.53	@346.99	28 88
11341 00	23.65	177 20	11337.54	32.00	-33 63	33.77 N	9.84W	35.18	@343.76	26.94
11373 00	32.54	177 55	11365.74	32.00	-18.61	18.74 N	9.15W	20 85	@333.96	27.79
11404.00	37.55	179.05	11391.11	31.00	-0 83	0.95 N	8.64W	8 69	@276.27	16.40
11436 00	42.30	181 60	11415.65	32.00	19.70	19.58 S	8.78W	21.46	@204 15	15.70
11468.00	47.66	183.18	11438.28	32.00	42 30	42.17 S	9.74W	43 28	@193.00	17.11
11500 00	55.75	181 24	11458.09	32.00	67.38	67.24 S	10 68W	68.08	@189.03	25.72

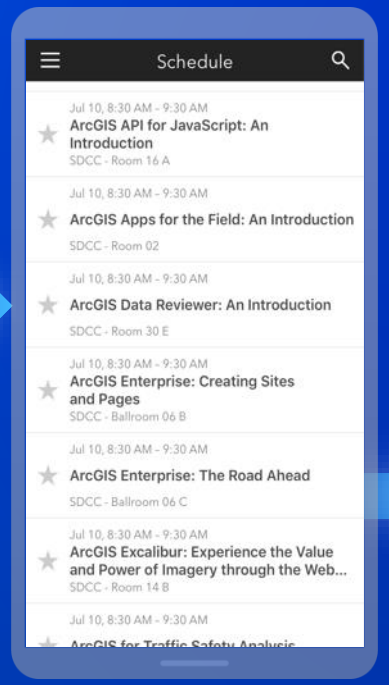
Sample data & Python script provided by University Lands: https://github.com/ULGISESRIUC2017

Please Share Your Feedback in the App

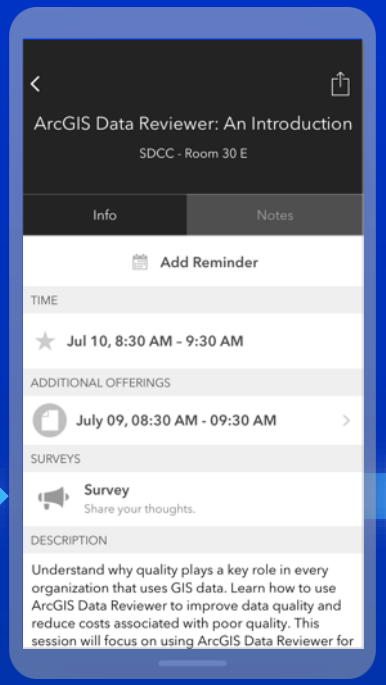
Download the Esri Events app and find your event



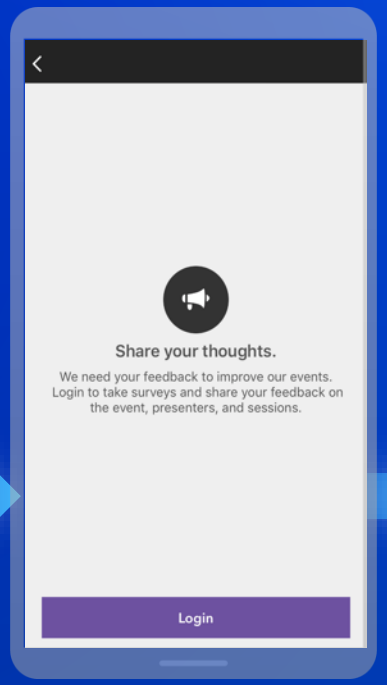
Select the session you attended



Scroll down to "Survey"



Log in to access the survey



Complete the survey and select "Submit"