Spatial Analyst Overview

- Over 100 geoprocessing tools plus raster functions
- Raster and vector analysis
- Construct workflows with ModelBuilder, Python, Raster Function editor
- Extend the analysis tools with Python
- Desktop, Enterprise, Online
Raster Analysis in the ArcGIS Platform

One engine, many access points
Geoprocessing Environment

Particularly important for raster analysis

- Cellsize
- Extent
  - Snap Raster
- Mask
- Map Projection
Getting Started with Spatial Analyst
Finding and Using Tools
Analysis Tools

- Mathematical Operators and Functions
- Distance and Proximity Analysis
- Density Mapping
- Neighborhood and Block Statistics
- Zonal Overlay
- Interpolation and Contouring
- Surface Analysis
- Hydrologic and Groundwater Analysis
- Reclassification and Rescaling
- Geometric Transformation
- Morphological Analysis
- Multivariate Statistical Analysis
- Image Segmentation and Classification
Mathematical Operators

- **Arithmetic** (+, -, *, /)
- **Boolean** (AND, OR, XOR, NOT)
- **Logical** (<, >, =, <>, etc.)
- **Bitwise** (shift, compliment)
Mathematical Functions

- Arithmetic—Abs, Int, Float, etc.
- Trigonometric—Sin, Cos, Tan, etc.
- Exponential—Exp, Exp2, Exp10
- Logarithmic—Log, Log2, Log10
- Powers—Sqr, Sqrt

The Int function

<table>
<thead>
<tr>
<th>Input raster</th>
<th>Output raster</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3 1.2 0.1 0.8</td>
<td>1 1 0 0</td>
</tr>
<tr>
<td>1.8 2.5 2.7</td>
<td>1 2 2</td>
</tr>
<tr>
<td>4.4 -1.9 -0.5 2.9</td>
<td>4 -1 0 2</td>
</tr>
<tr>
<td>4.6 0 1.7 1.5</td>
<td>4 0 1 1</td>
</tr>
</tbody>
</table>

= NoData
Map Algebra and the Raster Calculator tool

- An analysis language for raster data
  - Uses math-like expressions with operators and functions
  - Tight integration between Map Algebra and Python
  - All Geoprocessing tools
  - Import and use functions from other Python libraries
  - Process chain optimization to improve performance

\[ \text{SmoothHill} = \text{Hillshade}(\text{FocalStatistics}(\text{Elevation} * 0.3048)) \]

- Raster Calculator Geoprocessing tool provides easy construction of Map Algebra expressions
Distance and Proximity Analysis

- Straight line distance and allocation
  - Create distance buffers from features
  - Allocate resources to distribution centers

- Cost weighted distance and allocation
  - Include a weight or impedance surface to constrain movement

- Shortest path
  - Find least cost path between two points
  - Identify corridors of predicted travel

Best Paths and Cost Distance Analysis – Tuesday 3:15 or Wednesday 1:30
Corridor Analysis

Getting Started with Spatial Analyst

Corridor of low cost

Cost A

Cost B

Corridor

Corridor(s)

Adds two accumulative travel cost layers together

Alternate route?
Cost Connectivity
Optimized cost distance routing between multiple regions

- Output optimum paths
- Optional neighboring paths
Density Mapping

- Simple Density and Kernel Density

- Count occurrences of a phenomenon within an area
  "Magnitude per unit area"

- Use points or lines as input
  - Population per Km2
  - Road density per Mi2
Neighborhood and Block Statistics

- Used for filtering, data smoothing, and data aggregation

Statistics for neighborhoods

- Majority
- Maximum
- Mean
- Median
- Minimum
- Minority
- Range
- Sum
- Standard Deviation
- Variety
Zonal Overlay

- A **zone** is all the areas/cells with the same value
- Calculate a statistic within the zones for each cell in a raster
- Input zones can be feature or raster
- Output as a raster, summary table, or graph
  - Max flow length in each watershed
  - Median income in each ZIP CODE
  - Mean elevation per vegetation zone
Zonal Histogram

- Create histograms of cell counts within Zones
  - Same zone definitions as Zonal Statistics
  - Zones can also be classes defined in the renderer

- Investigate frequency/distribution of one dataset within classes of another dataset
  - Slope distribution within Land use classes
  - Rainfall distribution within Elevation classes
  - Crime distribution by beat
Interpolation and Contouring

• Generate surfaces from point measurements
  - Natural Neighbors
  - Minimum Curvature Spline
  - Spline with Barriers
  - TopoToRaster
  - Kriging
  - Polynomial Trend Surface
  - Inverse Distance Weighted

• Create contours from surfaces
  - Batch GP tools
  - Interactive contour button
Choosing an interpolation method

- You know nothing about your data…
  - Use **Natural Neighbors**. It is the most conservative. Assumes all highs and lows are sampled, will not create artifacts.

- Your input data is contours…
  - Use **TopoToRaster**. It is optimized for contour input. If not creating a DEM, turn off the drainage enforcement option.

- You know the highs and lows are not sampled…
  - Use **Spline**. Be careful of points that are near in space but very different in value creating unnatural artifacts.
  - Use Geostatistical Analyst **Kernel Smoothing Interpolation**

- Your surface is not continuous…
  - Use **Spline with Barriers** if you know there are faults or other discontinuities in the surface.

- You want or need a geostatistical technique
  - Use Geostatistical Analyst **Empirical Bayesian Kriging**
Interpolation and Contouring with Barriers

- Spline with Barriers tool – a Minimum Curvature Spline that honors barriers, faults, and void areas. **Now available in Pro**
- Contour with Barriers
Surface Analysis

- Hillshade
- Slope
- Aspect
- Viewshed
- Cut/Fill
- Curvature
Solar Radiation Tools

- Calculate amount of direct and indirect solar radiation on the earth’s surface.

- Applications in agriculture, hydrology, snow science, fire modeling, energy, etc.

- Two methods
  - Area
  - Point Locations
Building Blocks of Ski Suitability

- Euclidean Distance
- Natural Neighbors
- Slope
Reclassification and Transformation

- Reclassify individual values or ranges of values
- Transform continuous values

Used in site suitability models to put criteria on a common measurement scale.
Tools to transform your values – convert to suitability
Suitability Modeling with the Weighted Overlay or Weighted Sum tools

- Perform Weighted Overlay analysis for suitability modeling “where is the best place”
  - Combine multiple integer inputs
  - Weight layers
  - Weight classes
  - Supports NoData and restricted values
  - Easy to modify weights and try multiple scenarios

- Weighted Sum
  - Combine integer or float data
  - No restrictions on scales or weights
Building the Suitability Model

Reclassify
Weighted Overlay
**Fuzzy Suitability Modeling**

- 2 Geoprocessing tools - Fuzzy Reclassify, Fuzzy Overlay
- Useful in site selection and suitability modeling
- Similar to Weighted Overlay, but adds…
  - Continuous weighting like Rescale By Function
  - Fuzzy AND, OR, Gamma combinations (not just Plus)

*Great Basin Geothermal Potential*

*New Zealand Wind Energy Siting*
Finding the best contiguous areas from a suitability result

Locate Regions

- How many regions
- How big
- Shape of regions
- Compactness of regions
- Distance between regions
- Evaluation methods
Hydrologic Analysis

- Create watersheds and stream networks from DEMs
  - Flow Direction
  - Flow Accumulation
  - Watershed Delineation
  - Flow Length
  - Sink Filling
  - Stream Ordering

Large collection of free workflow and productivity tools available in *Arc Hydro* tools on GeoNet

Creating Watersheds and Stream Networks - Wednesday 10:00 Demo Theatre 18
Hydrologic and Hydraulic Modeling - Wednesday 3:15 Room 15A
Image Segmentation and Classification

Improving classification accuracy for higher resolution imagery

- Segmentation Geoprocessing Tools & Raster Functions
- Classification GP Tools and Raster Functions
  - Support Vector Machine
  - Maximum Likelihood
  - IsoCluster
  - Random Trees
- Accuracy Assessment GP Tools
- These tools and capabilities support Object-Based Image Analysis (OBIA) feature extraction methods
- Incorporates spatial and spectral image information, and other GIS information
Image Segmentation and Classification workflow wizard in ArcGIS Pro

Steps you through the full workflow of object based feature extraction

Thursday 11:30 Demo Theatre 14
Thursday 3:15 Room 15A
Generalization and Data Cleanup

- Smooth boundaries between zones
- Value replacement, nibbling
- Majority filtering
- Expand, shrink
- Group regions
- Raster thinning
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