Introduction to ArcGIS Spatial Analyst

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ArcGIS Spatial Analyst

• Integrated raster and vector spatial analysis tools

• Extension product that adds functionality to ArcGIS Desktop, Engine, and Server
Key Features of Spatial Analyst

- Over 170 geoprocessing tools
- Analysis on all raster formats
- Analysis on all vector formats
- Calculator with Map Algebra syntax
- Great developer experience
Spatial Analyst tools in a toolbar?

- Use standard Windows Customize to add your favorite tools and custom models.

- Use Search to find tools.
  - All previous tool and function names are part of the search index.
Geoprocessing Environment

- **Cells Size**
- **Extent**
  - Snap Raster
- **Mask**
- **Map Projection**
Data Exploration and Selection

• Cell-based identify
• Attribute-based selection
  - honored during analysis
• Histogram selected cells in a raster
  - selected by attribute, features in a Feature Theme, or a selected graphic
• Zonal Histogram
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
- Geometric Transformation
- Morphological Analysis
- Multivariate Statistical Analysis
Mathematical Operators

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

- Boolean (AND, OR, XOR, NOT)
- Logical (> , >=, =, <> , <, <=)
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

Input raster

Output raster

\[\begin{array}{cccc}
1.3 & 1.2 & 0.1 & 0.8 \\
 & 1.8 & 2.5 & 2.7 \\
4.4 & -1.9 & -0.5 & 2.9 \\
4.6 & 0 & 1.7 & 1.5 \\
\end{array}\]

\[\begin{array}{cccc}
1 & 1 & 0 & 0 \\
 & 1 & 2 & 2 \\
4 & -1 & 0 & 2 \\
4 & 0 & 1 & 1 \\
\end{array}\]

\[
\text{Input raster} = \text{Output raster}
\]

= 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

SmoothHill = Hillshade(FocalStatistics(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.
Distance and Proximity Analysis cont.
Corridor Analysis

From:
Cost Distance A
Cost Distance B

Corridor(s)

Adding two accumulative travel cost layers together

Cost A + Cost B = Corridor of low cost

Alternate route?
Density Mapping

- Simple Density and Kernel Density

- Count occurrences of a phenomenon within an area and distribute it through the area.
  
  *"Magnitude per unit area"*

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

- Calculates a statistic for a neighborhood
  - Majority, Maximum, Mean, Median, Minimum, Minority, Range, Sum, Standard Deviation, Variety

- Used for filtering, data smoothing, and data aggregation
Neighborhood Statistics

Mean of 3x3 neighborhood
Block Statistics

Mean of 3x3 neighborhood
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 Overlay (cont.)

Slope

Watersheds

Mean Slope per Watershed
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 Landuse classes
  - Rainfall distribution within Elevation classes
  - Crime distribution by beat

Slope distribution per Watershed
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 Local Polynomial 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

Creating Surfaces Wednesday 8:30 in Rm 15A
Interpolation and Contouring with Barriers

- Spline with Barriers tool – a Minimum Curvature Spline that honors barriers, faults, and void areas.
- 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.
  - Two methods
    - Area
    - Locations
- 3 geoprocessing tools
  - Area Solar Radiation
  - Point Solar Radiation
  - Solar Radiation Graphics
    - Diagnostic raster “maps” of sky, viewshed, and sun tracks used in the analysis.
- Applications in biology, agriculture, hydrology, snow science, fire modeling, energy, etc
Example Solar Radiation Analysis

Mean direct solar radiation (Wh/m²) on building rooftops for solar energy assessment.

http://gis.cityofboston.gov/solarboston/
http://www.slcgovsolar.com/
Building Blocks of Ski Suitability

Euclidian Distance
Natural Neighbors
Slope
Reclassification

- Reclassify individual values or ranges of values.
- Load and save reclass tables.
The Weighted Overlay tool

- Assign weights and combine multiple inputs
Weighted Overlay

• Perform Weighted Overlay analysis for suitability modeling "where is the best place"

- Weight layers
- Weight classes

- Supports NoData and restricted values

- Easy to modify weights and try multiple scenarios
Building the Suitability Model

Reclassify
Weighted Overlay
Fuzzy Overlay

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

Great Basin Geothermal Potential

New Zealand Wind Energy Siting
Hydrologic Analysis

- Create watersheds and stream networks from DEMs
  - Flow Direction
  - Flow Accumulation
  - Watershed Delineation
  - Flow Length
  - Sink Filling
  - Stream Ordering
Hydrologic Analysis (cont.)

Flow Direction

Flow Accumulation

Downstream flow length

Sink

Filled sink

More on these tools, Tuesday 1:30 in Rm 1B
Groundwater Modeling

- Creates groundwater flow fields
- Two-dimensional advection and dispersion modeling
- Functions
  - DarcyFlow
  - ParticleTrack
  - PorousPuff
  - Sample script to create well capture zones

Tracking particles from a contaminant spill to a pumping well using the Particle Track tool. From this analysis it can be determined if the contaminant is getting into the drinking water for a nearby town.
Multivariate Statistics

- Class Signatures, Edit Signatures, Dendrogram
- Principal Component, Iso Cluster, MLC Classify
- Class Probability, Band Collection Statistics
Image Classification

- Exposes image classification capabilities in a toolbar
- Includes capabilities for easy collecting and evaluating training samples
Generalization and Data Cleanup

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

Image Classification Toolbar
Supervised Classification
Analysis and Geoprocessing Resource Center

- **resources.arcgis.com**
  - (This is the home page. From here, navigate to the Analysis community page.)

**Option 1:** from the home page

**Option 2:** click “Communities” to get a list of all resource centers
Important features of the Analysis Resource Center

- **Quick Links:**
  - **Education Gallery:** you can find User Conference presentations here
  - **About the tool gallery:** learn all about the new gallery of geoprocessing tools and analysis hosted on ArcGIS Online

- **Gallery:**
  - A sample of entries in the tool gallery
  - Click **More Gallery posts** to see all the entries
Steps to evaluate UC sessions

• My UC Homepage > “Evaluate Sessions”

• Choose session from planner
  OR

• Search for session

www.esri.com/ucsurveysessions
• Thank you for attending
• Have fun at UC2012
• Open for Questions

• Please fill out the evaluation:

www.esri.com/ucsessionssurveys

First Offering ID: 641
Second Offering ID: 811
ArcGIS Spatial Analyst Technical Sessions

- **An Introduction - Rm 15B**
  Tuesday, July 24, 8:30AM – 9:45AM  
  Wed, July 25, 1:30PM – 2:45PM

- **Suitability Modeling - Rm 15A**
  Tuesday, July 24, 10:15AM – 11:30AM  
  Thursday, July 26, 3:15PM – 4:30PM

- **Raster Analysis with Python – Ballroom 6E**
  Tuesday, July 23, 3:15PM – 4:30PM  
  Thursday, July 25, 3:15PM – 4:30PM

- **Creating Surfaces – Rm 15A**
  Wednesday, July 25, 8:30PM – 9:45PM
ArcGIS Spatial Analyst Short Technical Sessions

- **Creating Watersheds and Stream Networks – Rm 01B**
  Tuesday, July 24, 1:30 PM – 1:50PM

- **Performing Regression Analysis Using Raster Data – 01A**
  Tuesday, July 24, 9:20AM – 9:40AM
Demo Theater Presentations – Exhibit Hall C

- **Modeling Rooftop Solar Energy Potential**
  Tuesday, July 24, 11:30AM – 12:00PM

- **Surface Interpolation in ArcGIS**
  Wednesday, July 25, 1:00PM – 2:00PM

- **Getting Started with Map Algebra**
  Thursday, July 26, 10:00AM – 11:00AM

- **Agent-Based Modeling**
  Wednesday, July 25, 12:00PM – 1:00PM