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 Overview
Spatial Analyst toolbar

- Dropdown list of functions is gone, 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

- Cellsize
- 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
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](image1) = ![Output raster](image2) = NoData
Map Algebra and the new 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))

- New Raster Calculator Geoprocessing tool provides easy access to Map Algebra
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.
Corridor Analysis

From:
Cost Distance A
Cost Distance B

Corridor

Corridor(s)

Adds 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 phenomena 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

5 6 2 1 9
5 3 7 4 5
7 2 1 4 9
2 5 1 6 7
2 6 3 4 6

3.22
### Block Statistics

#### Mean of 3x3 neighborhood

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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.)

Mean Slope per Watershed

Slope

Watersheds
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
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’s 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.

• Your surface is not continuous…
  - Use Spline with Barriers if you know there are faults or other discontinuities in the surface.
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 \textit{“where is the best place”}
  - Weight layers
  - Weight classes
  - Supports NoData and restricted values
  - \textit{Easier to use, explain, and modify than using reclass and map algebra}
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…
  - 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

Pour Point

Watershed

Sink

Filled sink

Stream Ordering

More on these tools, Tuesday 10:40 in Rm 6A
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, MLClassify
- Class Probability, Band Collection Statistics
Image Classification

- Exposes image classification capabilities in a new toolbar
- Includes new 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
Image Classification Toolbar

Supervised Classification
Questions & Answers

Please fill out the session evaluation forms

Thank you
ArcGIS Spatial Analyst Technical Sessions

- **An Introduction - Rm 1 A/B**
  Tuesday, July 12, 8:30AM – 9:45AM
  Thursday, July 14, 10:15AM – 11:30AM

- **Suitability Modeling - Rm 1 A/B**
  Tuesday, July 12, 1:30PM – 2:45PM
  Thursday, July 14, 8:30AM – 9:45AM

- **Dynamic Simulation Modeling – Rm 5 A/B**
  Wednesday, July 13, 8:30AM – 9:45AM

- **Raster Analysis with Python – Rm 6C**
  Tuesday, July 12, 3:15PM – 4:30PM
  Wednesday, July 13, 3:15PM – 4:30PM

- **Creating Surfaces – Rm 1 A/B**
  Wednesday, July 13, 1:30PM – 2:45PM
ArcGIS Spatial Analyst Short Technical Sessions

• Creating Watersheds and Stream Networks – Rm 6A
  Tuesday, July 12, 10:40AM – 11:00AM

• Performing Image Classification – Rm 6B
  Tuesday, July 12, 8:30AM – 8:50AM

• Performing Regression Analysis Using Raster Data – 6B
  Tuesday, July 12, 8:55AM – 9:15AM
Demo Theater Presentations – Exhibit Hall C

- **Modeling Rooftop Solar Energy Potential**  
  Tuesday, July 12, 3:30PM – 4:00PM

- **Surface Interpolation in ArcGIS**  
  Wednesday, July 13, 9:00AM – 10:00AM

- **Getting Started with Map Algebra**  
  Wednesday, July 13, 10:00AM – 11:00AM

- **Agent Based Modeling**  
  Wednesday, July 13, 5:30PM – 6:00PM