ArcGIS Spatial Analyst

• Integrated raster and vector spatial analysis tools

• Extension product that adds functionality to ArcGIS Desktop, Engine, Server, Online
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 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

- Cellsize
- Extent
  - Snap Raster
- Mask
- Map Projection
Selection and Data Exploration

- Selection honored during analysis
- Histogram selected cells in a raster
  - selected by attribute, features in a Feature Layer, 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

<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></td>
</tr>
<tr>
<td>1.8 2.5 2.7</td>
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<td>4.4 -1.9 -0.5 2.9</td>
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</tr>
<tr>
<td>4.6 0 1.7 1.5</td>
<td></td>
</tr>
</tbody>
</table>

\[ = \text{NoData} \]
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.

- Straight Line Distance
- Direction
- Allocation
- Cost Weighted Distance
- Shortest Path
  - Five Hours
  - Ten Hours
Corridor Analysis

From:
Cost Distance
Path Distance

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 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

- 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 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.
- Contour with Barriers
Surface Analysis

- Hillshade
- Slope
- Aspect
- Viewshed
- Cut/Fill
- Curvature

Also available in ArcGIS Online
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

- 3 geoprocessing tools
  - Area Solar Radiation
  - Point Solar Radiation
  - Solar Radiation Graphics

http://gis.cityofboston.gov/solarboston/
http://www.slgovsolar.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)
Hydrologic Analysis

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

Also available in ArcGIS Online

More on these tools, Tuesday 11:00 in Theatre 1 Exhibit Hall A
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 toolbar
- Includes capabilities for easy collecting and evaluating training samples
Image Classification Toolbar
Supervised Classification
Generalization and Data Cleanup

- Smooth boundaries between zones
- Value replacement, nibbling
- Majority filtering
- Expand, shrink
- Group regions
- Raster thinning
Analysis and Geoprocessing Resource Center

• Additional analysis tools and scripts for Spatial Analyst and other projects

• [resources.arcgis.com](http://resources.arcgis.com)
Thank you…

Please fill out the session evaluation

First Offering ID:
Second Offering ID:

Online – www.esri.com/ucsessionssurveys
Paper – pick up and put in drop box