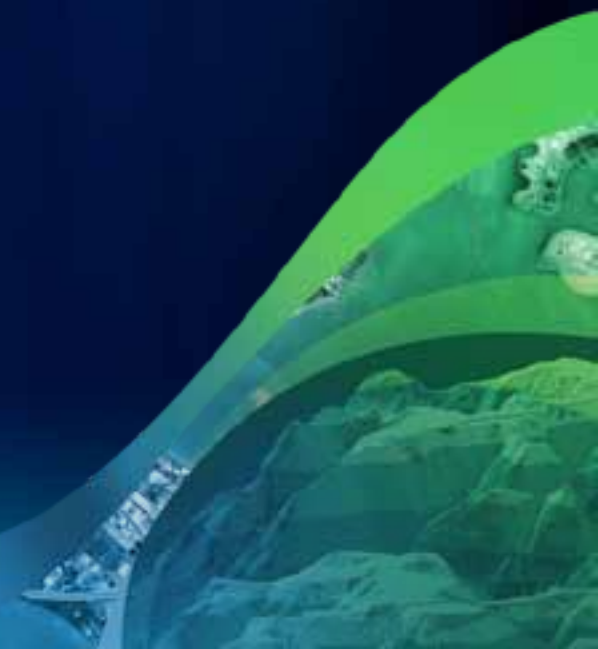
Esri International User Conference | San Diego, CA

Technical Workshops | July 2011

Introduction to ArcGIS Spatial Analyst

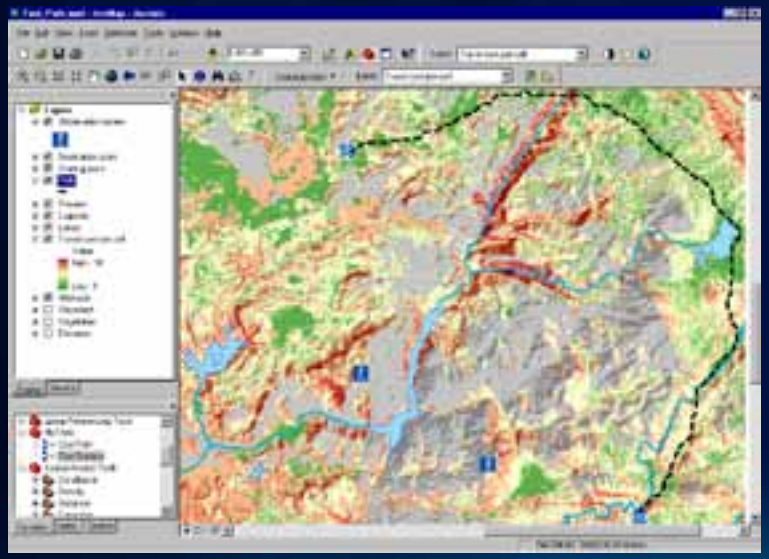
Steve Kopp

Elizabeth Graham



ArcGIS Spatial Analyst

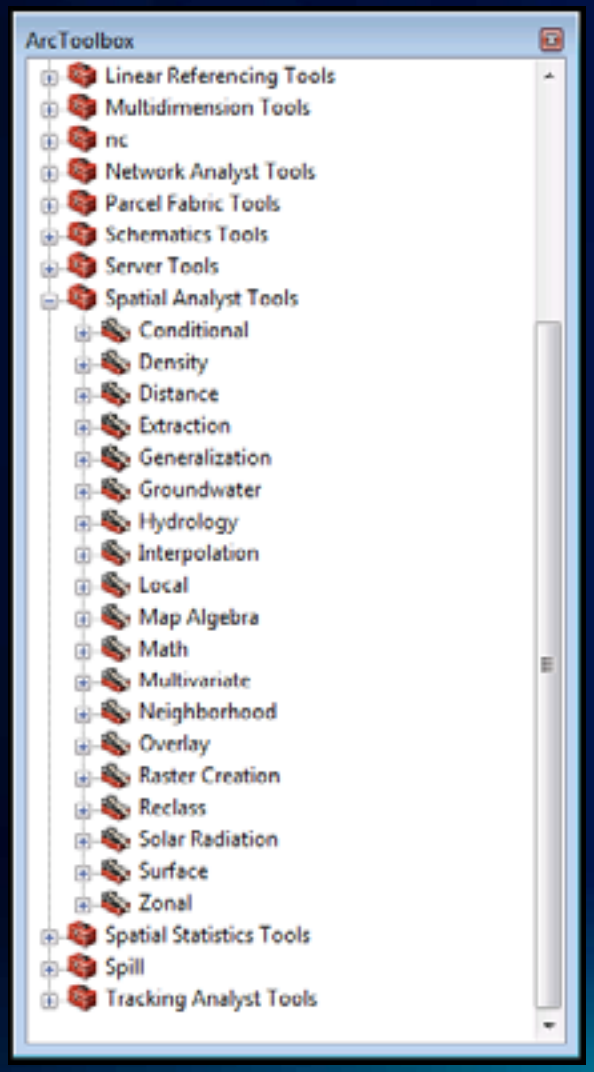
- Integrated raster and vector spatial analysis tools
- Extension product that adds functionality to ArcGIS Desktop, Engine, and Server

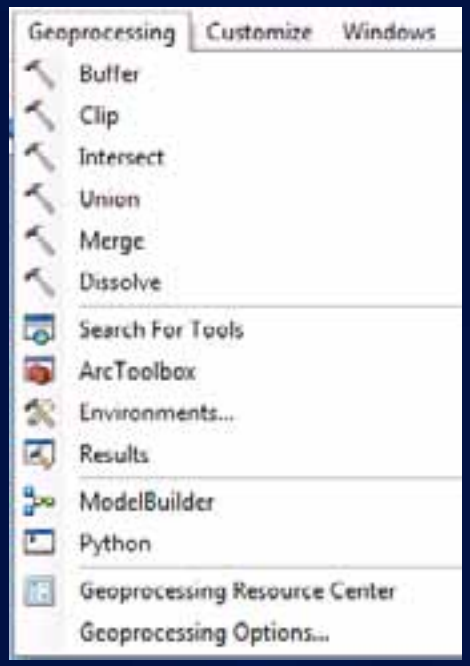


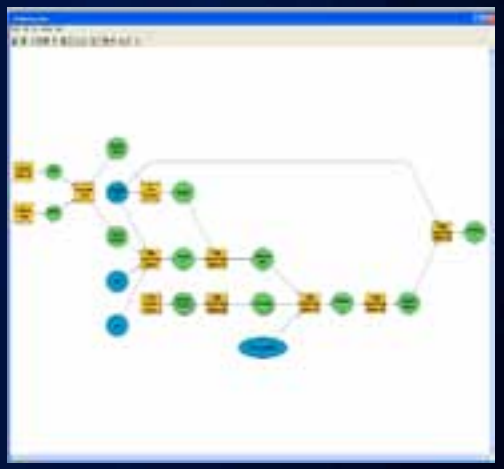
Key Features of Spatial Analyst

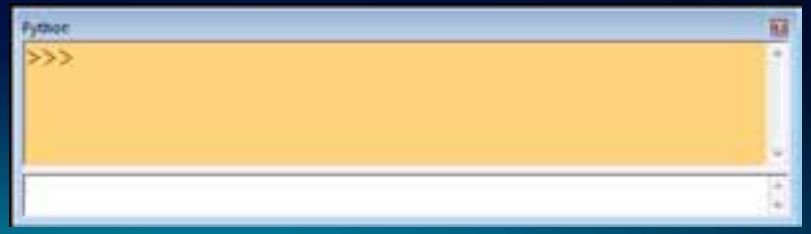
- Over 170 geoprocessing tools
- Analysis on all raster formats
- Analysis on all vector formats
- Calculator with Map Algebra syntax
- Great developer experience

Spatial Analyst Overview



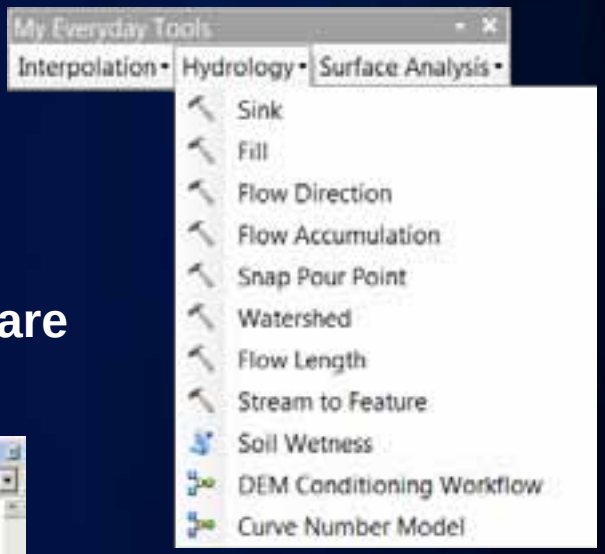




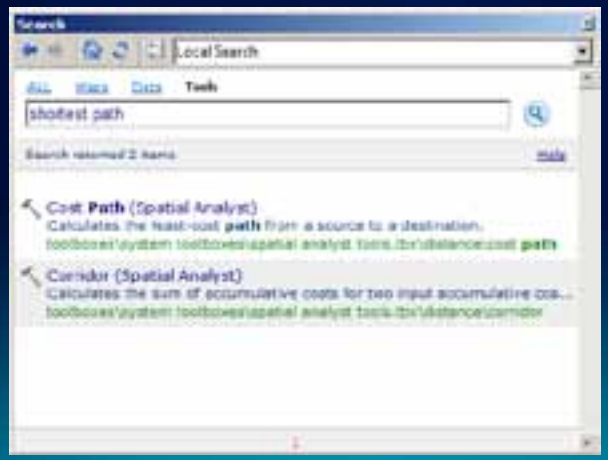


Spatial Analyst toolbar

- Dropdown list of functions is gone, use standard Windows Customize to add your favorite tools and custom models

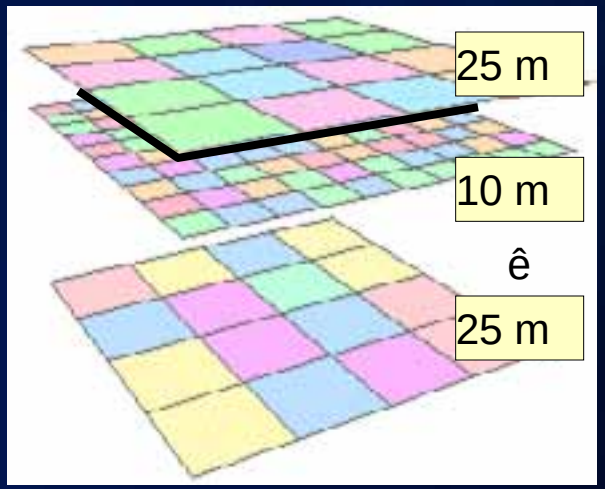


- Use Search to find tools
  - All previous tool and function names are part of the search index



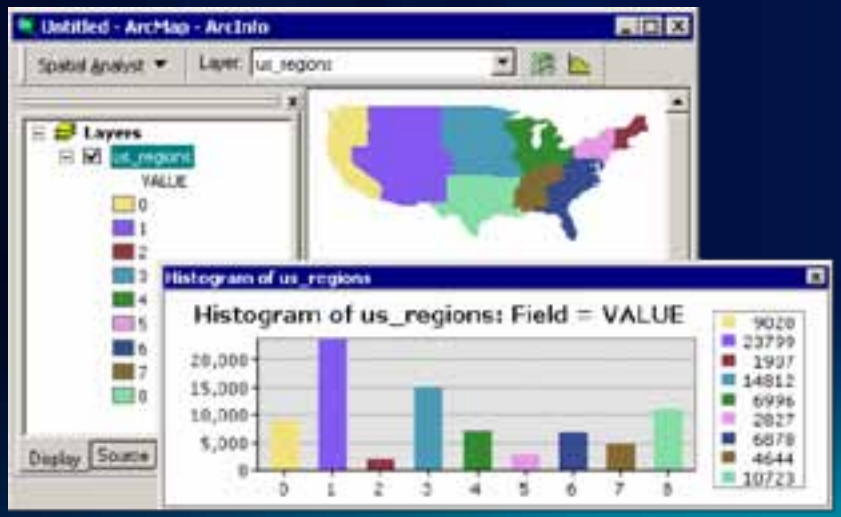
Geoprocessing Environment

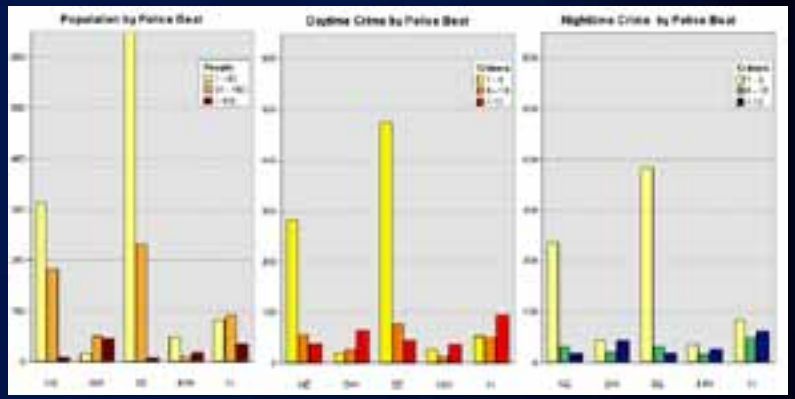
- Cellsize
- Extent
  - Snap Raster
- Mask
- Map Projection



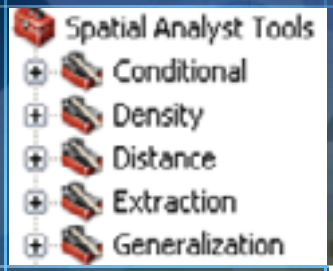
Data Exploration and Selection

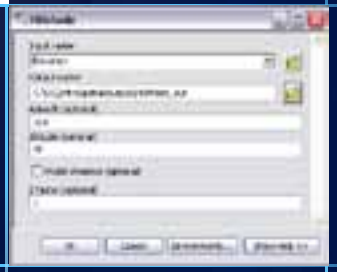
- Cell-based identify
- Attribute-based selection
  - honored during analysis
- Histogram selected cells in a raster
  - selected by attribute, features in a Feature Theme, or a selected graphic
- Zonal Histogram





Getting Started with Spatial Analyst





Analysis Tools

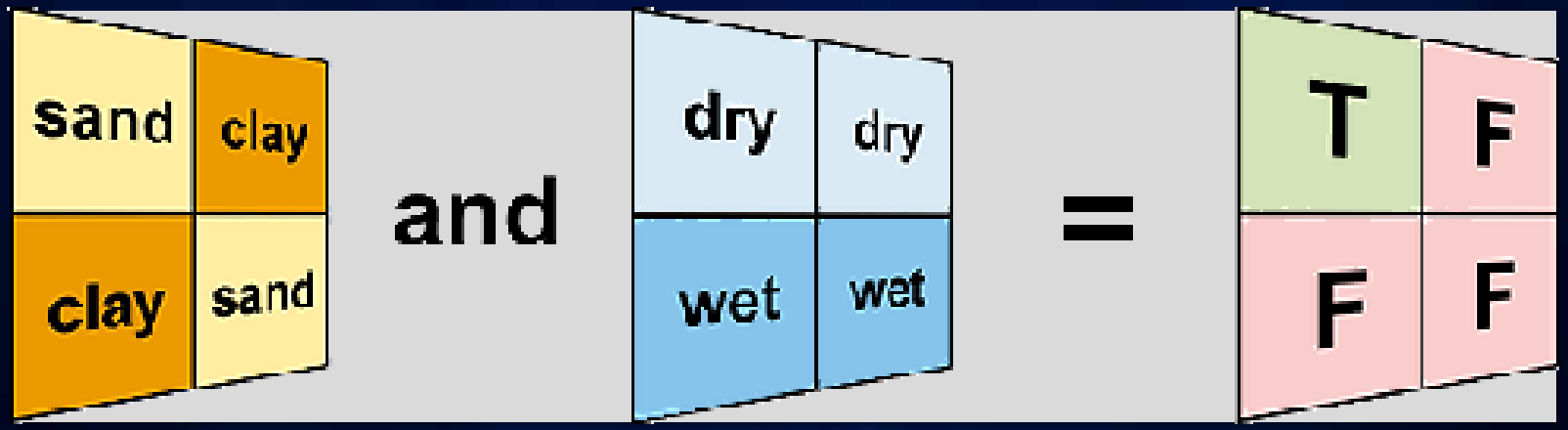
- Mathematical Operators and Functions
- Distance and Proximity Analysis
- Density Mapping
- Neighborhood and Block Statistics
- Zonal Overlay
- Interpolation and Contouring
- Surface Analysis
- Hydrologic and Groundwater Analysis
- Reclassification
- Geometric Transformation
- Morphological Analysis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

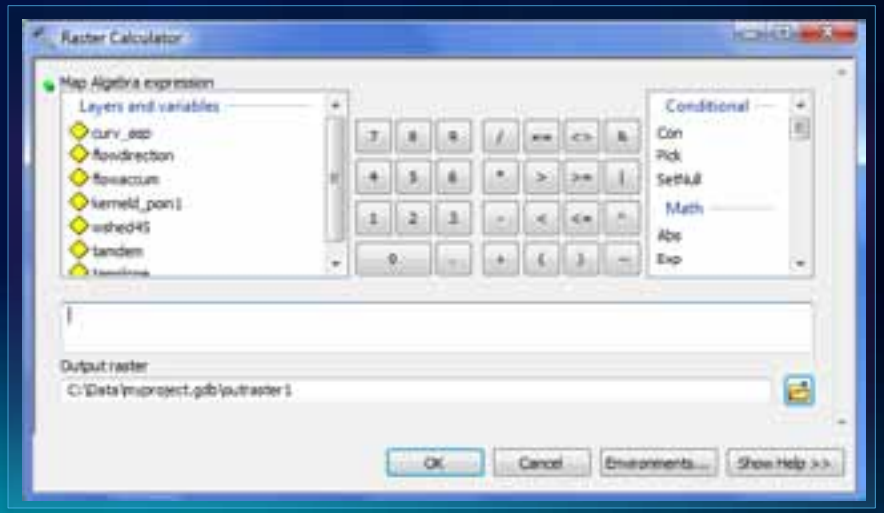
The Int function

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))
```

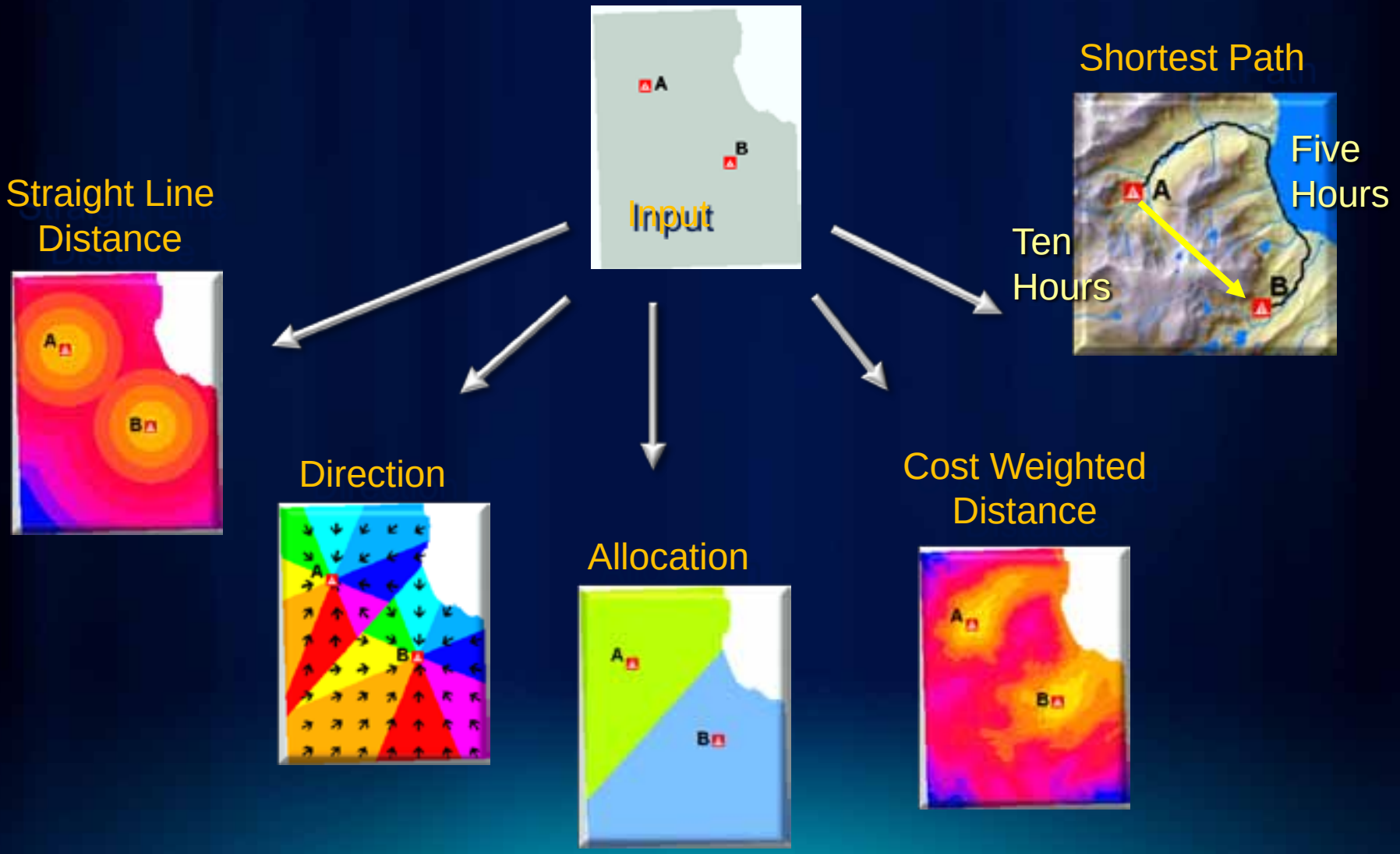
- New Raster Calculator Geoprocessing tool provides easy access to Map Algebra



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.

Distance and Proximity Analysis cont.



Corridor Analysis

From:
Cost Distance
Path Distance

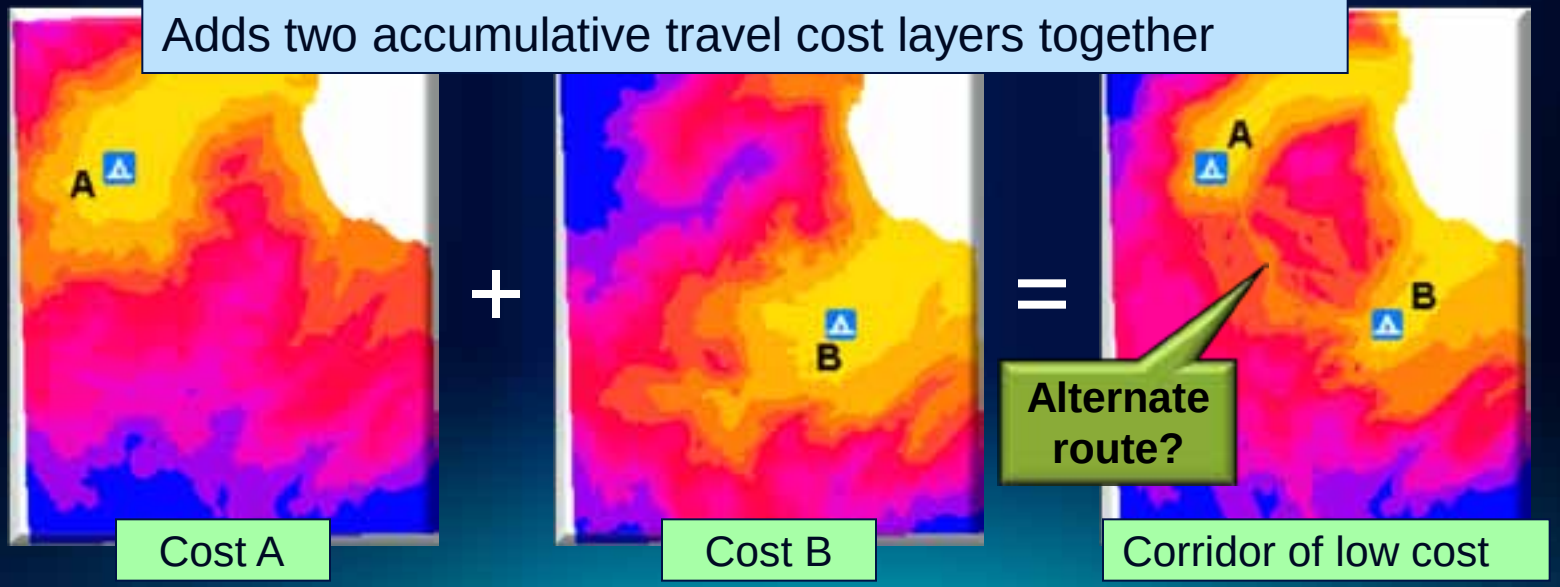
Cost Distance A

Cost Distance B

Corridor

Corridor(s)

Adds two accumulative travel cost layers together

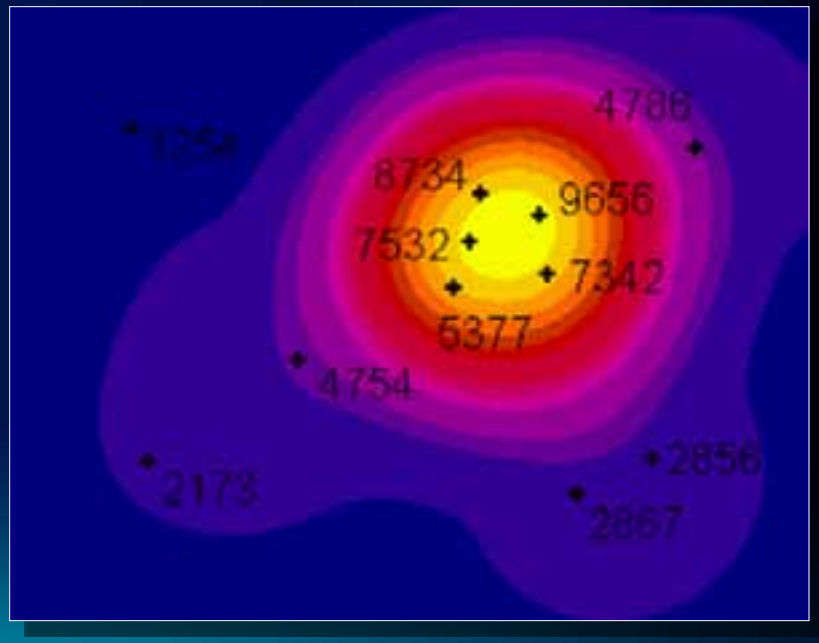


Density Mapping

- **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

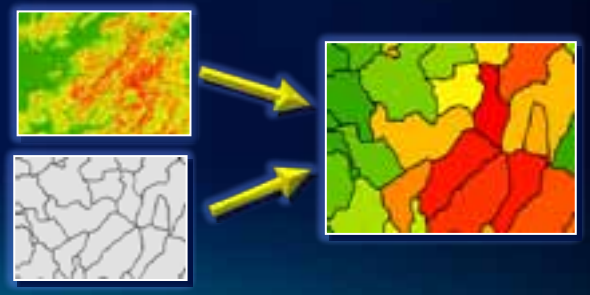
Mean of 3x3 neighborhood

Block Statistics

Mean of 3x3 neighborhood

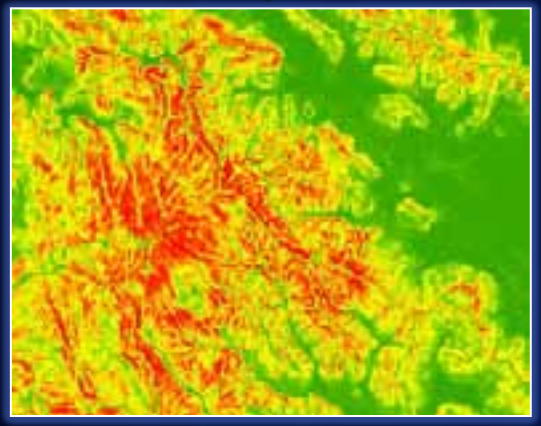
Zonal Overlay

- 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



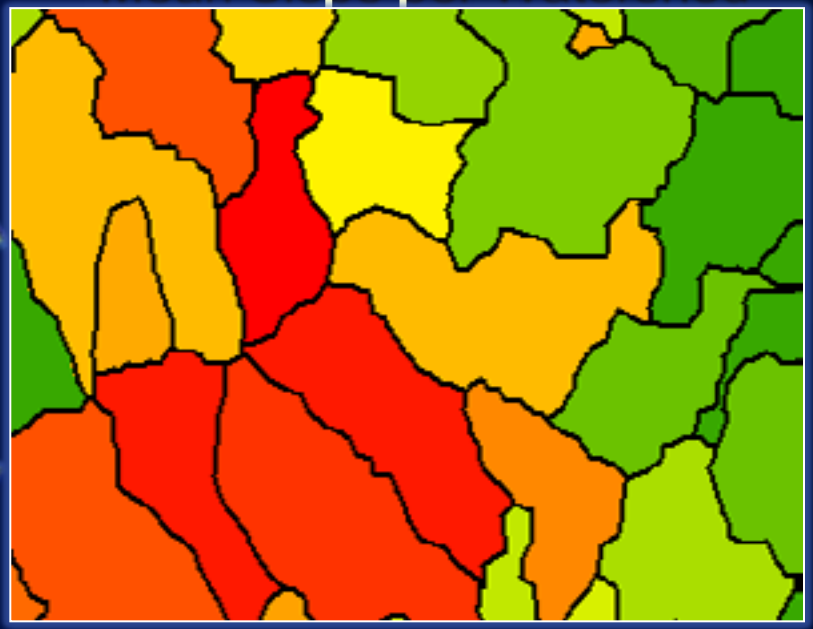
Zonal Overlay (cont.)

Slope



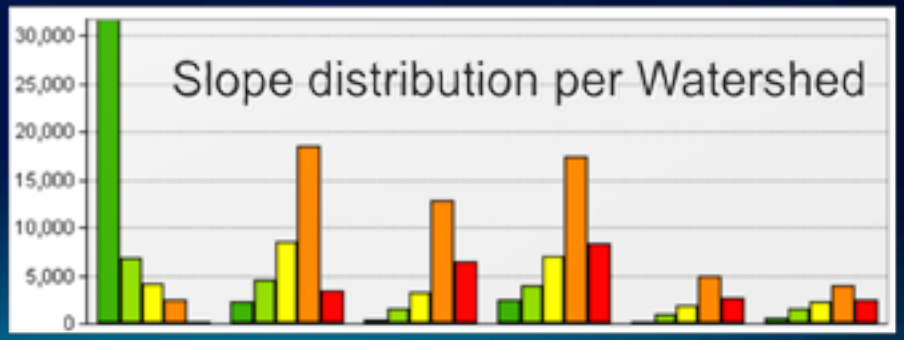
Watersheds

Mean Slope per Watershed



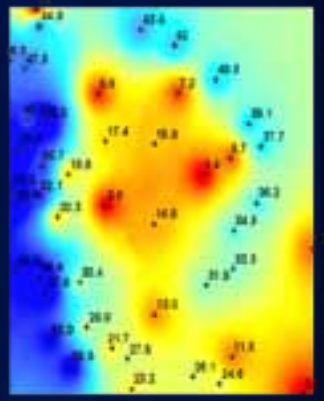
Zonal Histogram

- 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



Interpolation and Contouring

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



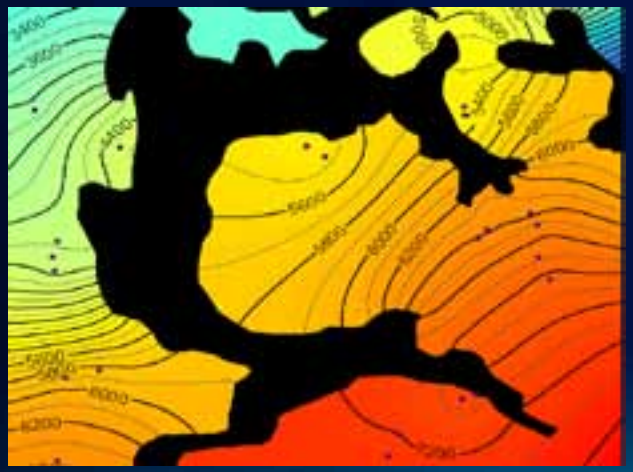
- Create contours from surfaces
  - Batch GP tools
  - Interactive contour button

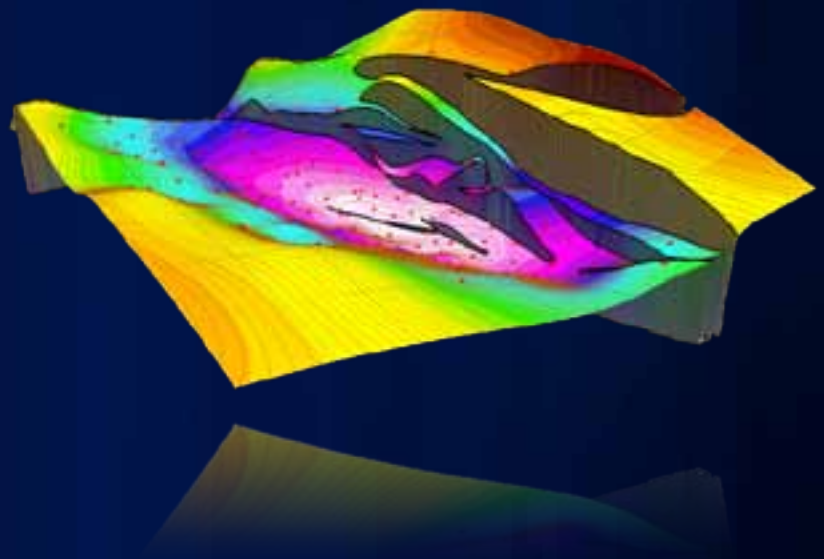
Choosing an interpolation method

- You know nothing about your data…
  - Use Natural Neighbors. Its 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

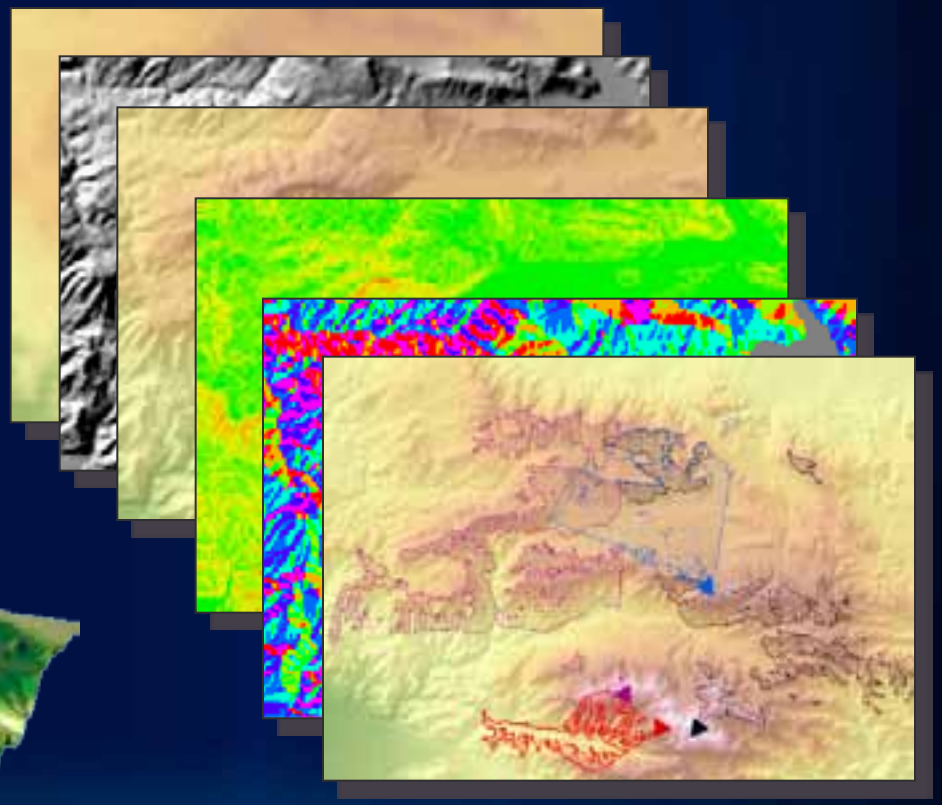
- **Spline with Barriers tool – a Minimum Curvature Spline that honors barriers, faults, and void areas.**
- **Contour with Barriers**

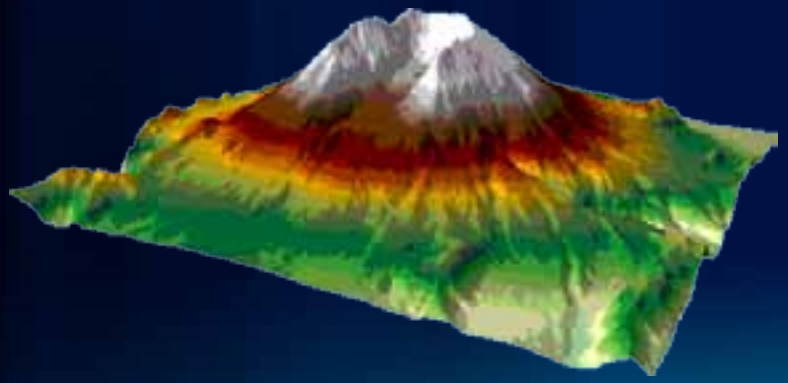




Surface Analysis

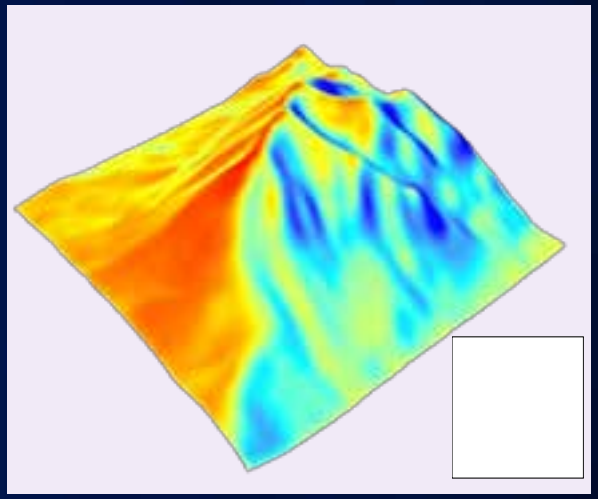
- Hillshade
- Slope
- Aspect
- Viewshed
- Cut/Fill
- Curvature



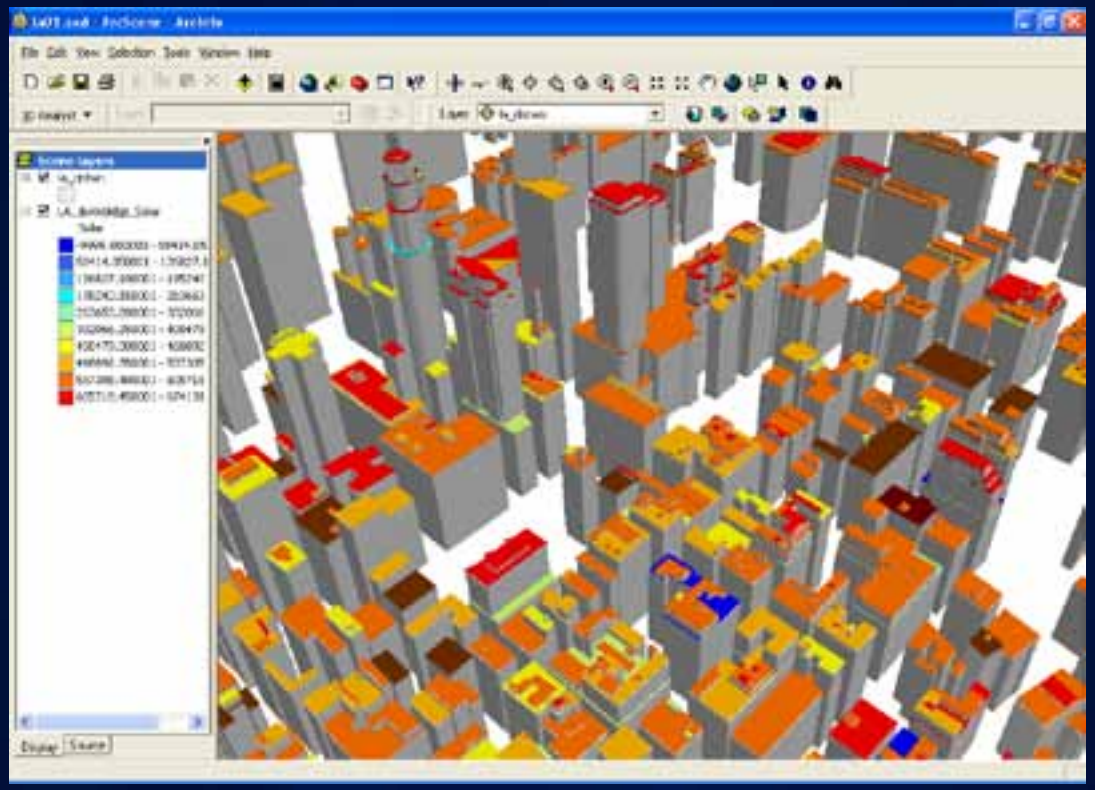


Solar Radiation Tools

- 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



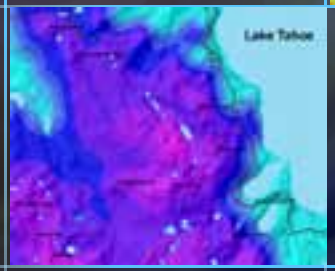
Example Solar Radiation Analysis



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



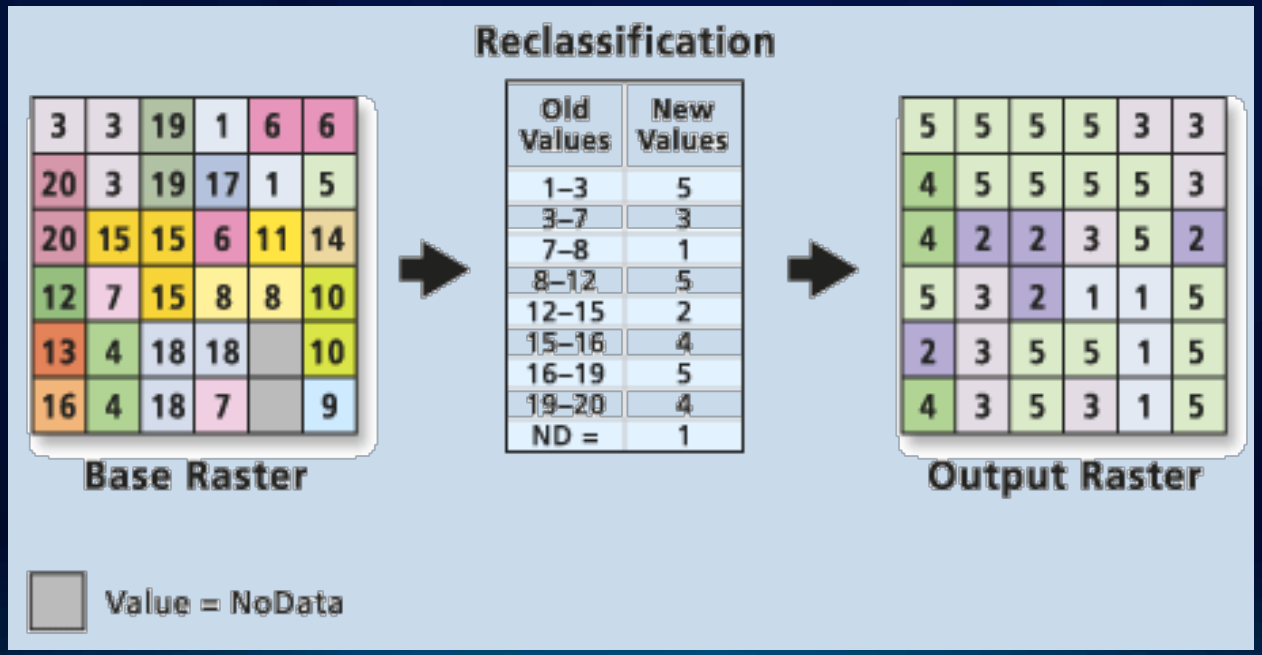
Euclidian Distance

Natural Neighbors

Slope

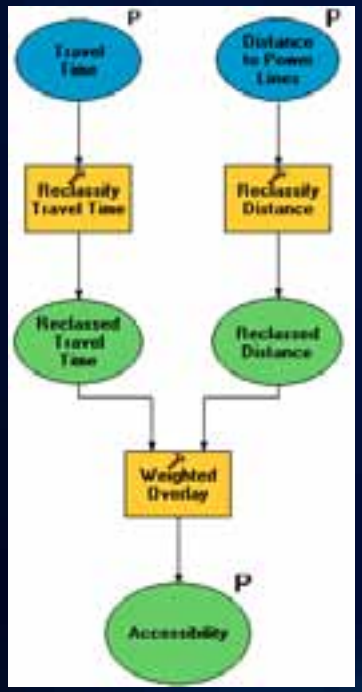
Reclassification

- 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 *"where is the best place"***
  - **Weight layers**
  - **Weight classes**
  - **Supports NoData and restricted values**
  - ***Easier to use, explain, and modify than using reclass and map algebra***

Building the Suitability Model

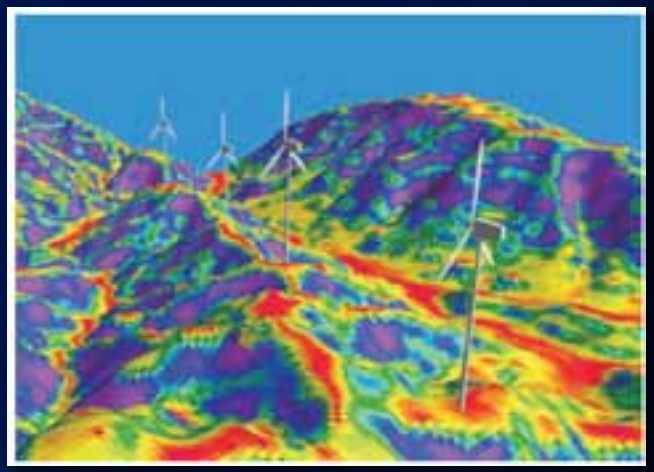
Reclassify

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

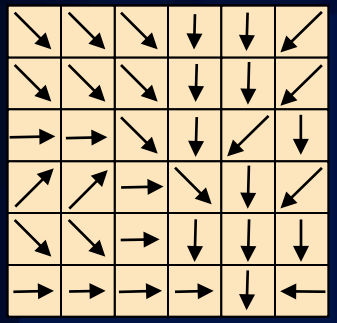


New Zealand Wind Energy Siting

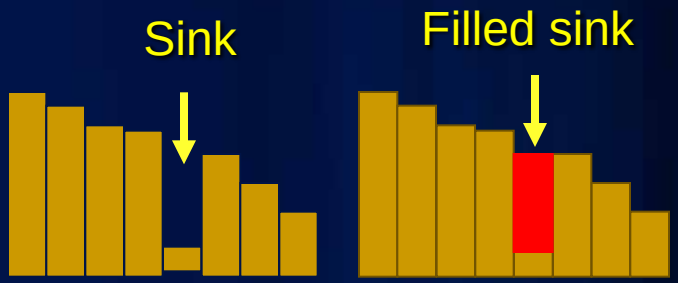
Hydrologic Analysis

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

Hydrologic Analysis (cont.)



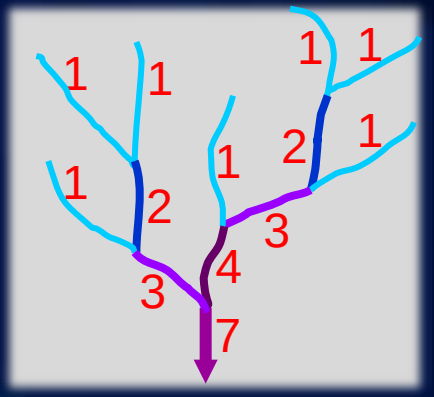
Flow Direction



0	0	0	0	0	0
0	1	1	2	2	0
0	3	7	5	4	0
0	0	0	20	0	1
0	0	0	1	24	0
0	2	4	7	35	1

Flow Accumulation

Downstream flow length

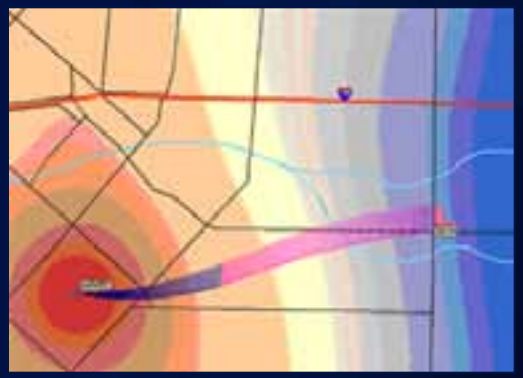


Stream Ordering

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

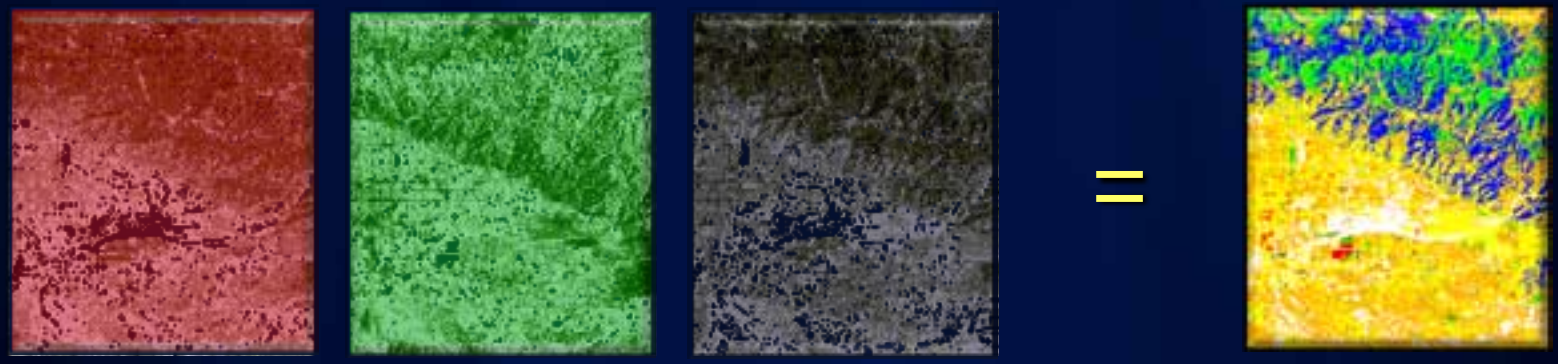
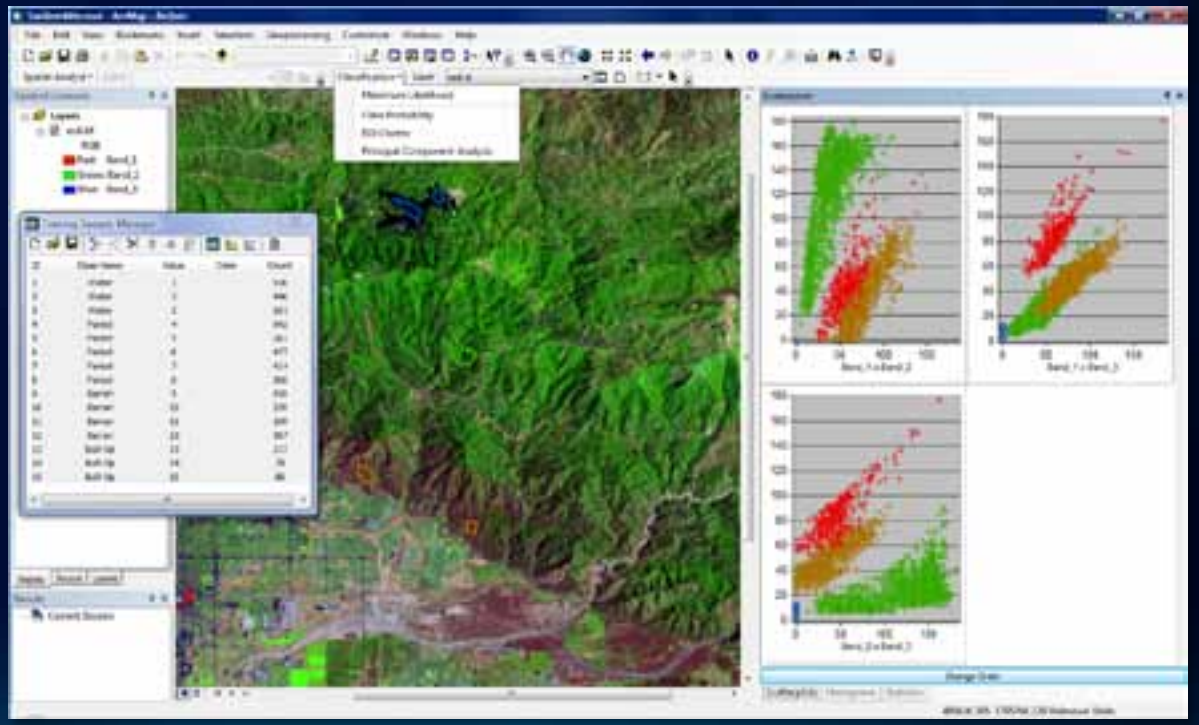


Image Classification

- 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

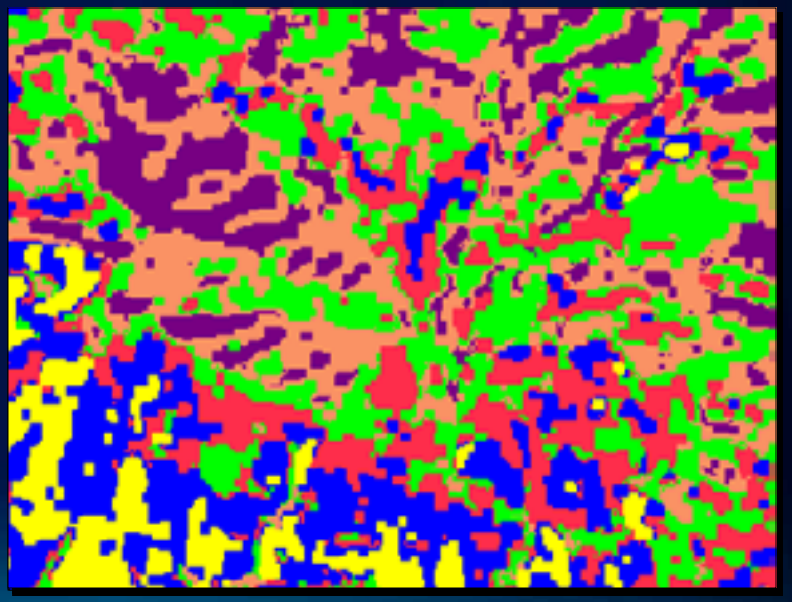
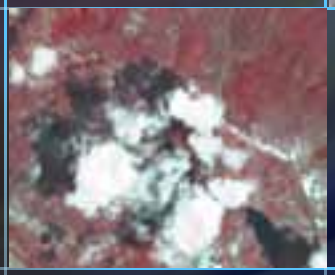
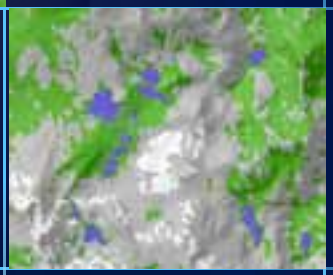


Image Classification Toolbar





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