



Introduction to Spatial Analysis and Spatial Modeling

1

Benefits of raster GIS

- ❑ **ArcGIS raster support**
- ❑ **The ArcGIS Spatial Analysis extension**
 - The seven interfaces
 - Installation and licensing
- ❑ **Exercise 1**
 - Introduction to the interfaces

Benefits of raster GIS

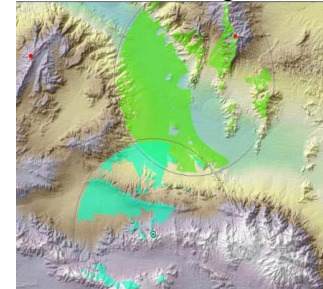
❑ Location-based data model (cells)

- Better than features for many types of analyses

❑ Especially suited for

- Surface creation and analysis
 - Elevation, rainfall, population
- Location models
 - Best site for business, hospital
- Distance measurement
 - Proximity, mobility, best path
- Modeling movement
 - Flood inundation, fire spread

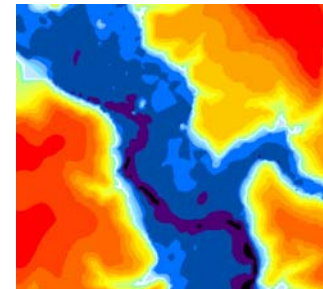
Modeling



Distances



Surfaces

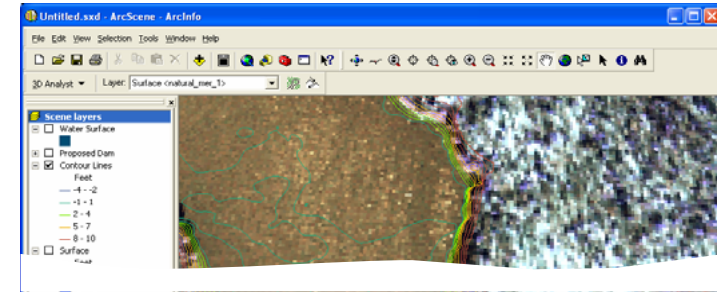


ArcGIS raster support

❑ ArcGIS has out-of-the-box raster support

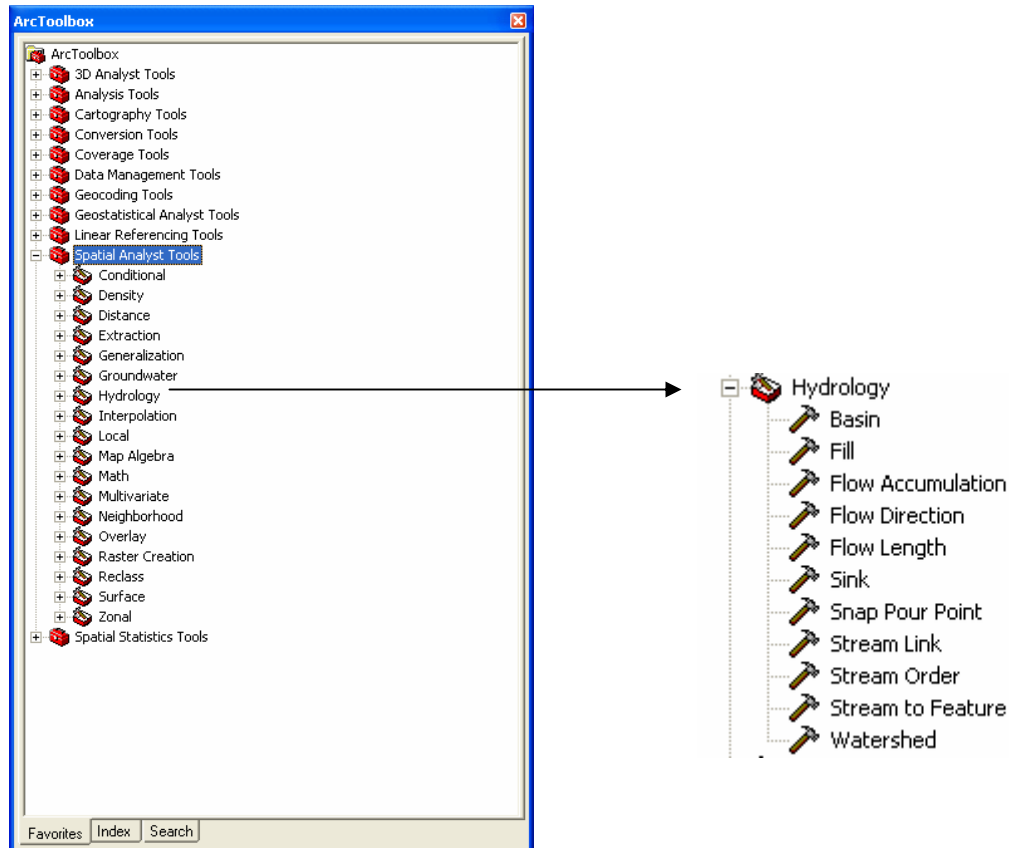
- Use with ArcMap
 - Draw, query, georeference
- Manage with ArcCatalog
 - Copy, rename, delete,
- Manipulate with ArcToolbox
 - Convert, project, merge, clip,
- Store with a geodatabase
 - Raster datasets and catalogs

❑ Add Spatial Analyst for analysis

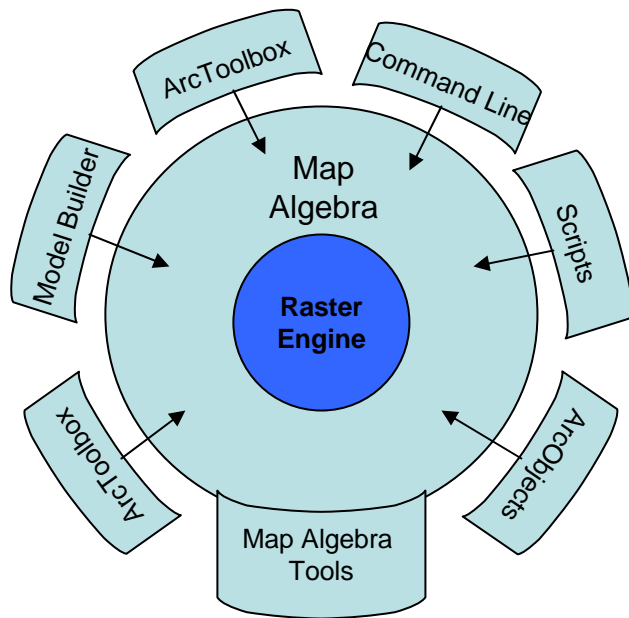


Spatial Analysis tools

❑ Over 100 tools organized into toolsets

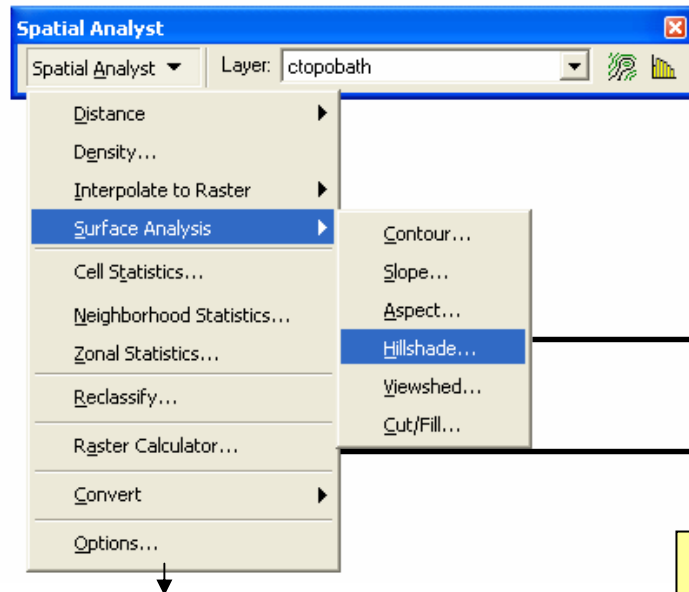


Seven interfaces for Spatial Analyst

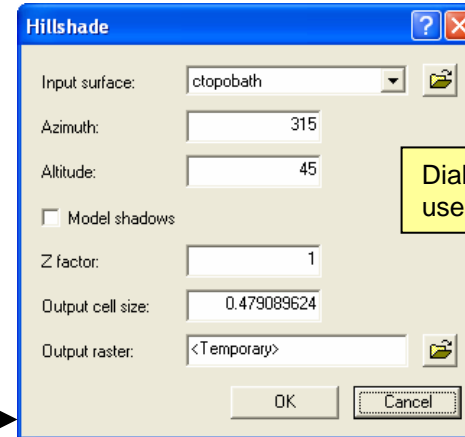


- ☐ 1. ArcToolbox
Dialogs for all tools
 - ☐ 2. Command Line
Type commands
 - ☐ 3. Model Builder
Visual modeling
 - ☐ 4. Scripts
Write easy programs
 - ☐ 5. Spatial Analyst Toolbar
Dialogs for common tools
 - ☐ 6. ArcObjects
More programming power
 - ☐ 7. Map Algebra Tools
For all interfaces
- ☐ Most become Map Algebra
☐ Evaluated by Raster Engine

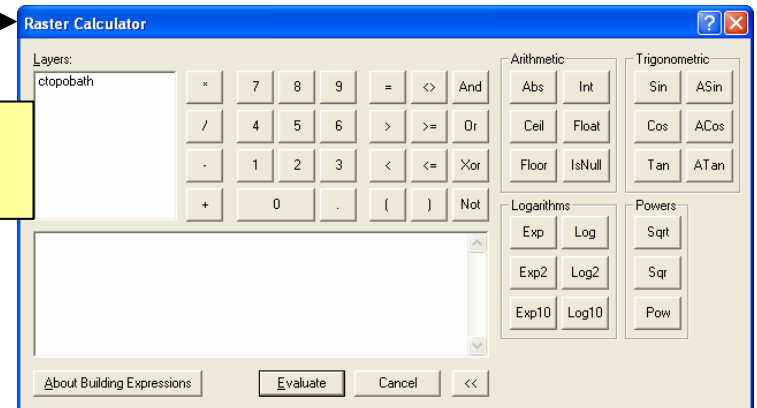
The Spatial Analyst toolbar



Has its own environment
(not part of the geoprocessing)



Dialogs for commonly
used tools



Can compose
Map Algebra
expressions

Spatial Analyst and ArcToolbox

The image shows a screenshot of the ArcGIS software interface. At the top is the 'Standard' toolbar with various icons for file operations, editing, and navigation. Below it is the 'ArcToolbox' window, which is a tree view of geoprocessing tools. The 'Surface' folder is expanded, and the 'Aspect' tool is selected. To the right of the 'Aspect' tool in the tree is a small icon of a globe. Below the 'Aspect' tool is a yellow callout box with the text 'Hints and links to help'. The 'Aspect' dialog box is open, showing the 'Input raster' and 'Output raster' fields. Below the dialog box is a yellow callout box with the text 'Opens ArcToolbox'. At the bottom of the 'Aspect' dialog box are buttons for 'OK', 'Cancel', 'Environments...', and '<< Hide Help'. A yellow callout box at the bottom right contains a list of features: 'Uses geoprocessing environments (right-click to set)' and 'Has Map Algebra tools'.

Standard

ArcToolbox

Conditional
Density
Distance
Extraction
Generalization
Groundwater
Hydrology
Interpolation
Local
Map Algebra
Math
Multivariate
Neighborhood
Overlay
Raster Creation
Reclass
Surface
Aspect
Contour
Contour List
Curvature
Cut/Fill
Hillshade
Observer Points
Slope
Viewshed
Zonal
Spatial Statistics Tools

Aspect

Input raster
Output raster

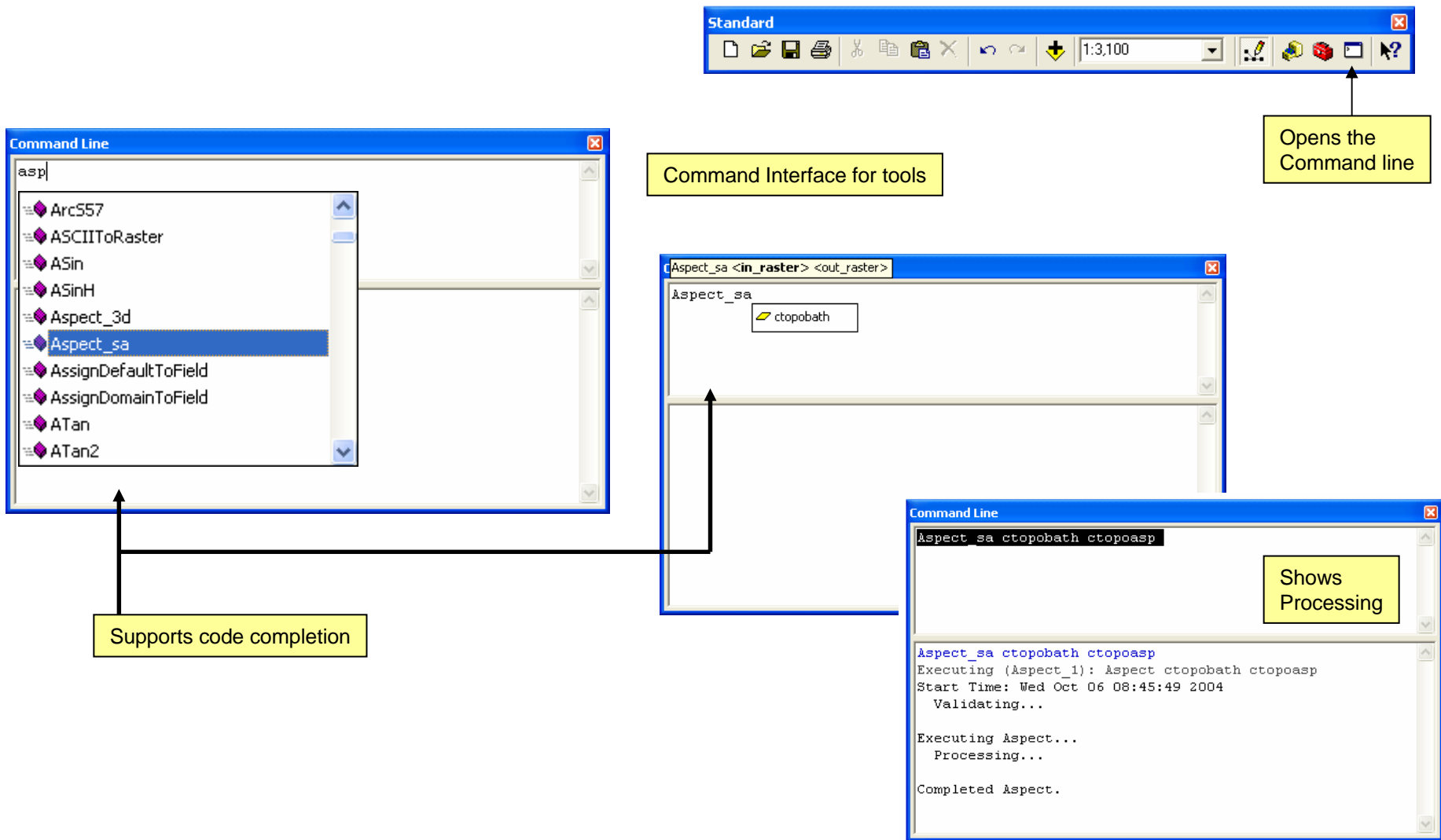
OK Cancel Environments... << Hide Help

Opens ArcToolbox

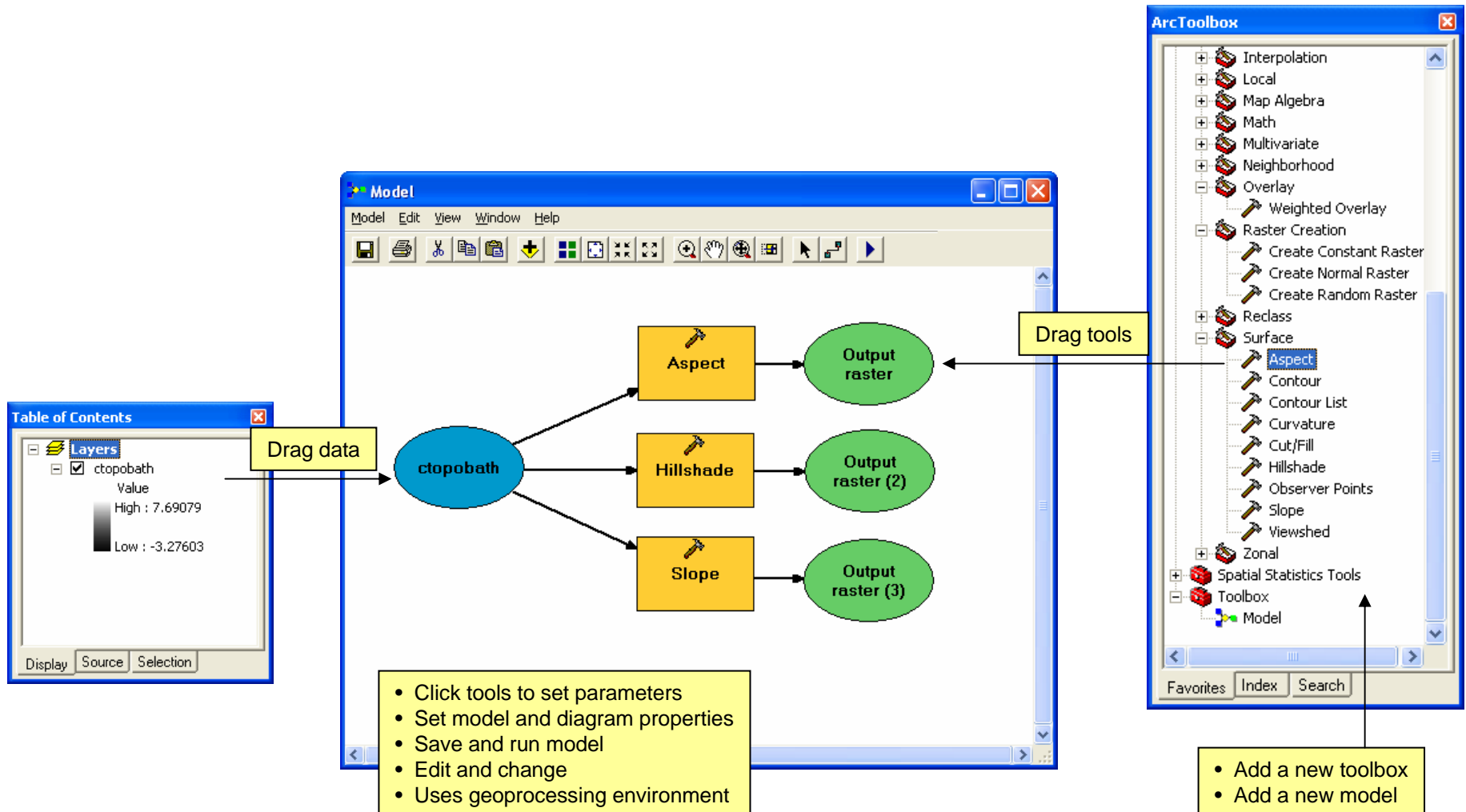
Hints and links to help

- Uses geoprocessing environments (right-click to set)
- Has Map Algebra tools

Spatial Analyst and Command Line

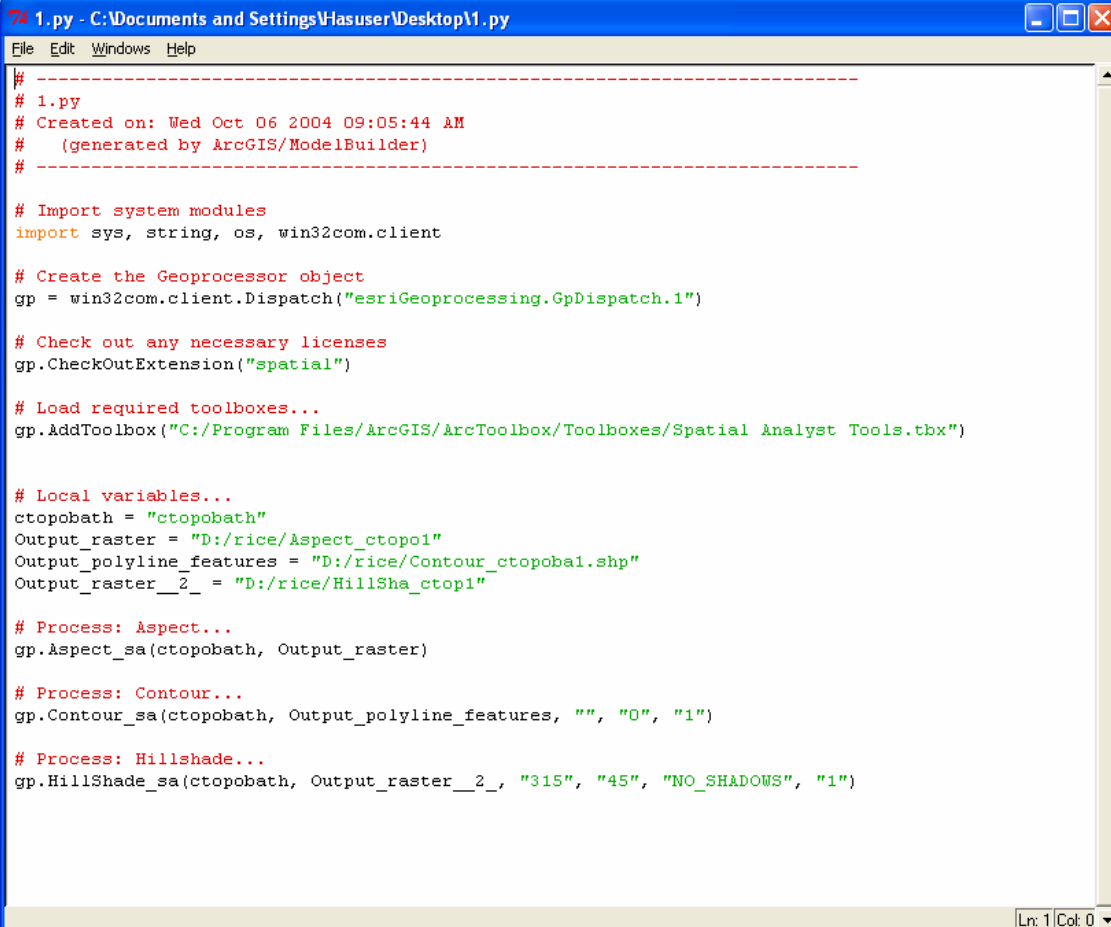


Spatial Analyst and Model Builder



Spatial Analyst and scripts

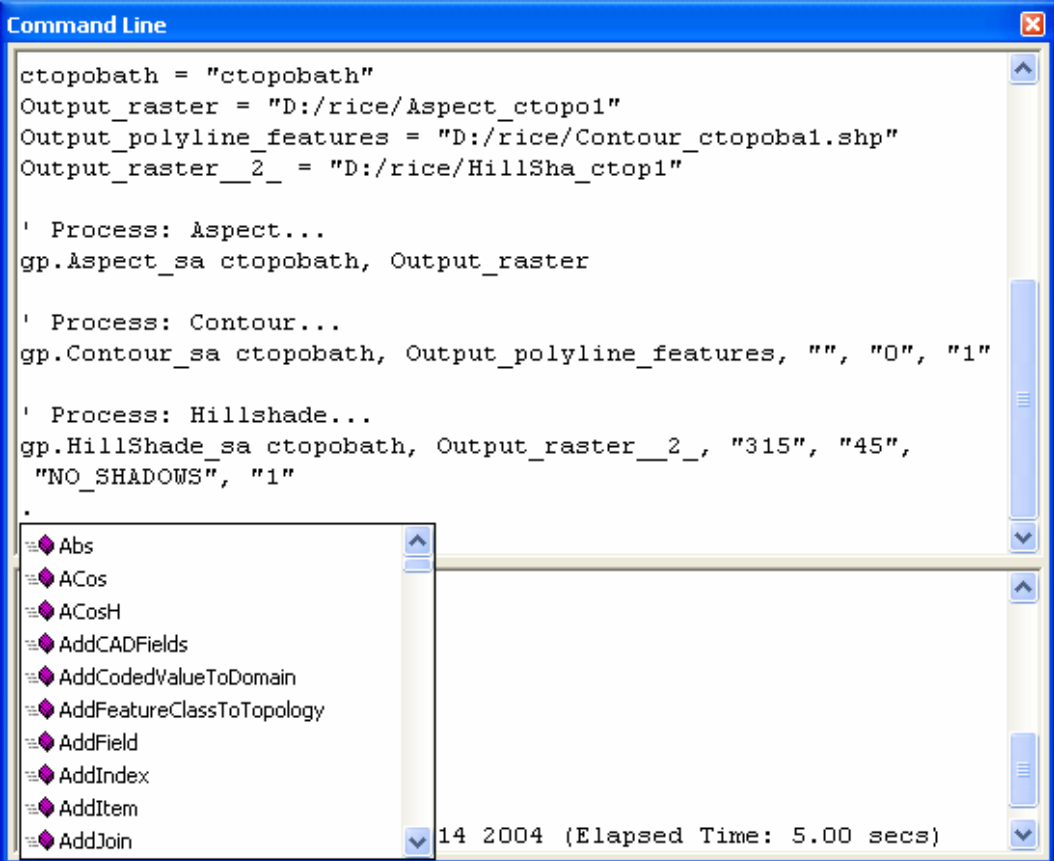
- ☐ Many languages are supported (Python shown)
- ☐ Is object-oriented (But easy!)
- ☐ Uses geoprocessor tools, environments
- ☐ May add scripts to ArcToolbox
- ☐ May use scripts in models
- ☐ Has a Map Algebra tool



```
# -----  
# 1.py  
# Created on: Wed Oct 06 2004 09:05:44 AM  
# (generated by ArcGIS/ModelBuilder)  
# -----  
  
# Import system modules  
import sys, string, os, win32com.client  
  
# Create the Geoprocessor object  
gp = win32com.client.Dispatch("esriGeoprocessing.GpDispatch.1")  
  
# Check out any necessary licenses  
gp.CheckOutExtension("spatial")  
  
# Load required toolboxes...  
gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Spatial Analyst Tools.tbx")  
  
# Local variables...  
ctopobath = "ctopobath"  
Output_raster = "D:/rice/Aspect_ctop1"  
Output_polyline_features = "D:/rice/Contour_ctopoba1.shp"  
Output_raster__2_ = "D:/rice/HillSha_ctop1"  
  
# Process: Aspect...  
gp.Aspect_sa(ctopobath, Output_raster)  
  
# Process: Contour...  
gp.Contour_sa(ctopobath, Output_polyline_features, "", "0", "1")  
  
# Process: Hillshade...  
gp.HillShade_sa(ctopobath, Output_raster__2_, "315", "45", "NO_SHADOWS", "1")
```

Spatial Analyst and ArcObjects

- ❑ Many languages are supported (VBA shown)
- ❑ Is object-oriented (Powerful, but a lot of classes to learn)
- ❑ Must set your environments
- ❑ Build stand-alone applications, or build tools, or ...?
- ❑ Has classes for Map Algebra



The screenshot shows the 'Command Line' window in ArcGIS. The main text area contains VBA code for three processes: Aspect, Contour, and Hillshade. Below the text area is a scrollable list of available classes, including Abs, ACos, ACosh, AddCADFields, AddCodedValueToDomain, AddFeatureClassToTopology, AddField, AddIndex, AddItem, and AddJoin. The status bar at the bottom right indicates the date '14 2004' and the elapsed time '5.00 secs'.

```
Command Line

ctopobath = "ctopobath"
Output_raster = "D:/rice/Aspect_ctopob1"
Output_polyline_features = "D:/rice/Contour_ctopobal.shp"
Output_raster__2_ = "D:/rice/HillSha_ctop1"

' Process: Aspect...
gp.Aspect_sa ctopobath, Output_raster

' Process: Contour...
gp.Contour_sa ctopobath, Output_polyline_features, "", "0", "1"

' Process: Hillshade...
gp.HillShade_sa ctopobath, Output_raster__2_, "315", "45",
"NO_SHADOWS", "1"

.

◆ Abs
◆ ACos
◆ ACosh
◆ AddCADFields
◆ AddCodedValueToDomain
◆ AddFeatureClassToTopology
◆ AddField
◆ AddIndex
◆ AddItem
◆ AddJoin

14 2004 (Elapsed Time: 5.00 secs)
```

Spatial Analyst and Map Algebra

❑ An analysis language for raster data

- Uses math-like expressions with operators and functions:

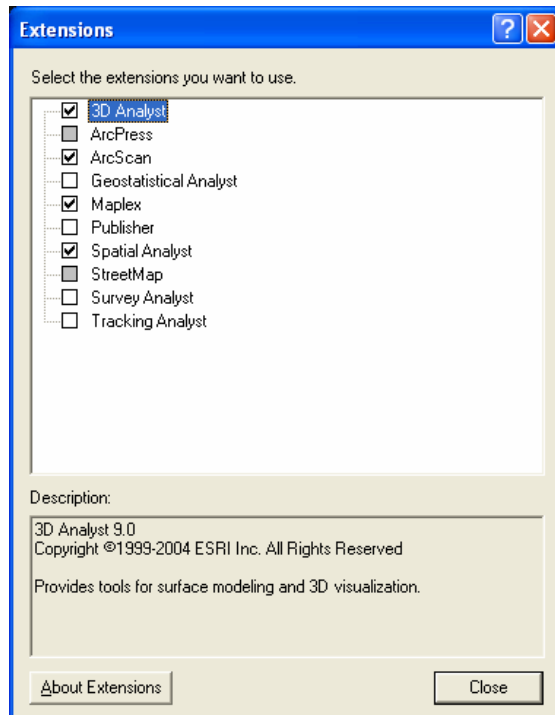
```
SmoothHill = Hillshade(FocalMean([Elevation] * 0.3048))
```

- Can be more efficient than Spatial Analyst tools (one expression may use many functions and operators)

❑ Spatial Analyst tools and Map Algebra

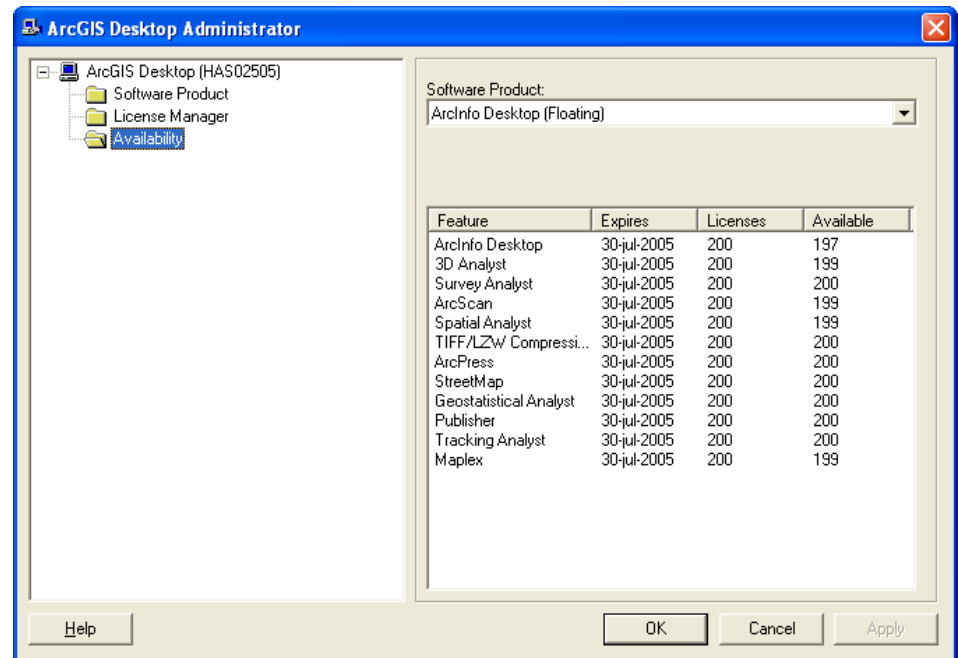
- Most tools implement Map Algebra functions and operators
 - Tools provide dialog and command line interfaces
 - Most tools implement a single function or operator (some implement many functions)
- Tools exist for writing Map Algebra expressions

Managing the extension



Tools > Extensions

- Enable or disable extensions



Start> Programs > ArcGIS> Desktop Administrator

- Select software product
- Select license manager
- Check license availability

Resources for self study

- ☐ Online Help
- ☐ For ArcGIS Desktop users and for developers
- ☐ Documentation
- ☐ ESRI Support Center
- ☐ Software information
- ☐ Knowledge Base
- ☐ Downloads
- ☐ User forums
- ☐ Developer support and tools
- ☐ Virtual Campus courses
- ☐ Self-learning modules

Exercise 1 overview

- ☐ Check the license in the Desktop Administrator
- ☐ Enable the extension in ArcMap
- ☐ Run a tool with the Spatial Analyst toolbar
- ☐ Run a tool with the ArcToolbox
- ☐ Run a tool with the Command Line window
- ☐ Build and run a model with the Model Builder
- ☐ Create and run a script and view its code
- ☐ Run and view a VBA program that uses ArcObjects
- ☐ Write and run a Map Algebra expression
- ☐ Install several ArcObjects-based utilities (you will use them in future exercises)