ESRI Developer Summit

March 22–25, 2010
Palm Springs, CA

Getting Started With Python In ArcGIS

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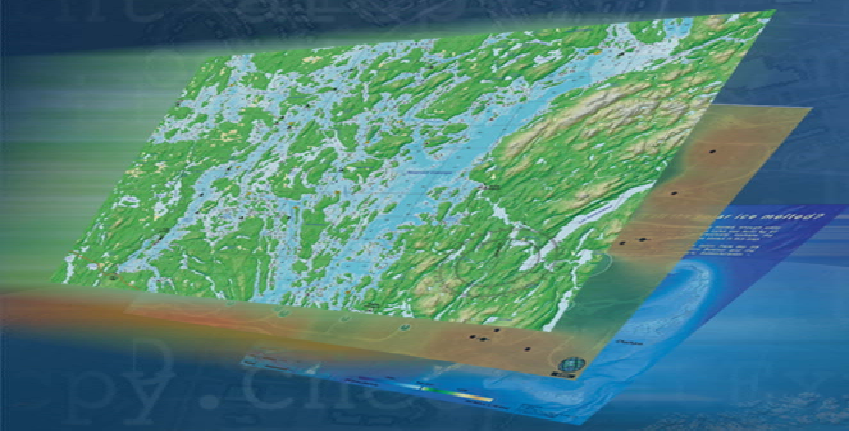

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Agenda

- 8:30 – 9:30: Python 101 and ArcPy 101
  - Essentials of the language
  - Using ArcPy to execute geoprocessing tools
  - Python window
- 9:30– 10:00: Script and Script tool basics
  - Creating a standalone script
  - Creating a script tool
- 10:00– 10:15: Map automation
- 10:15 –10:45: Break
- 10:45– 11:00: Raster analysis and Map Algebra
- 11:00– 11:45: Tool Design and Validation

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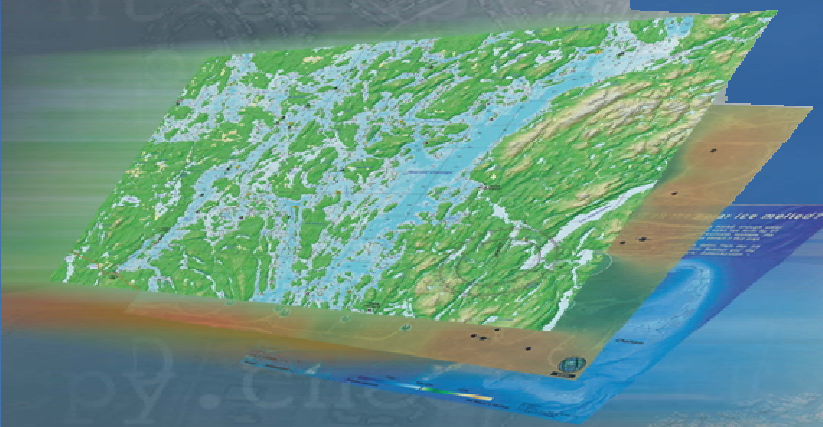
Python 101



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Why Python?

- ESRI has embraced Python for ArcGIS 10
- Python is the language that fulfills the needs of our user community
  - Easy to learn
  - Excellent for beginners and experts
  - Suitable for large projects or small scripts
  - Cross-platform

Python 101

- Clear, easy to read syntax
- Easy to use, makes it simple to get started
- Variety of basic data types
  - Including lists and dictionaries
- Comes with a large standard library
- Supports raising and catching exceptions
- Code can be grouped into modules and packages
- Supports object-oriented programming

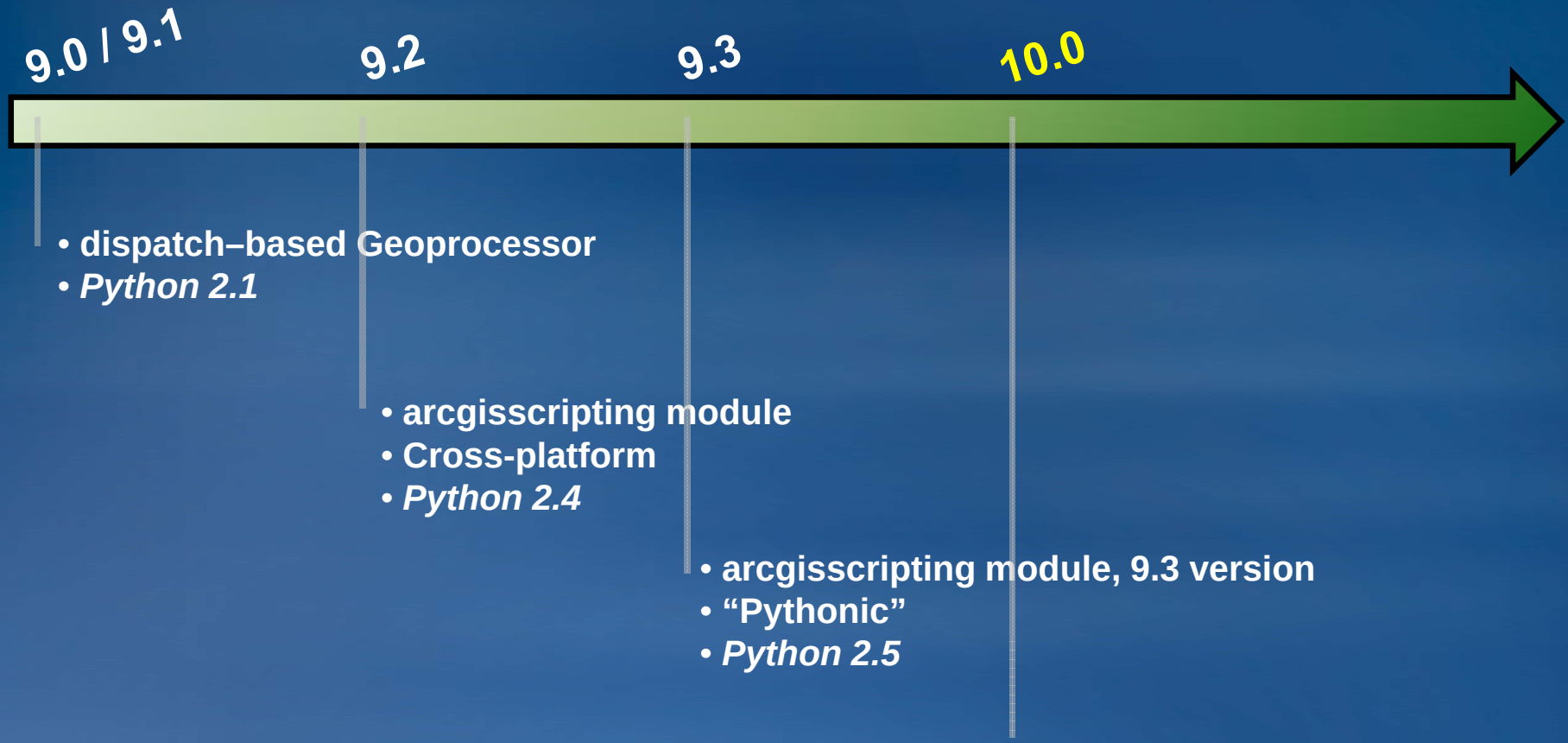
http://www.python.org/about/

Python at 10.0

- **ESRI has fully embraced Python as its language for automation**

1. **ArcPy site-package**
   - **Includes mapping and Map Algebra support**
   - **Successor to the arcgisscripting module**
2. **Python window**
   - **Python access and interaction from within ArcGIS**
3. **Python script tool framework**

A brief history of Python in ArcGIS



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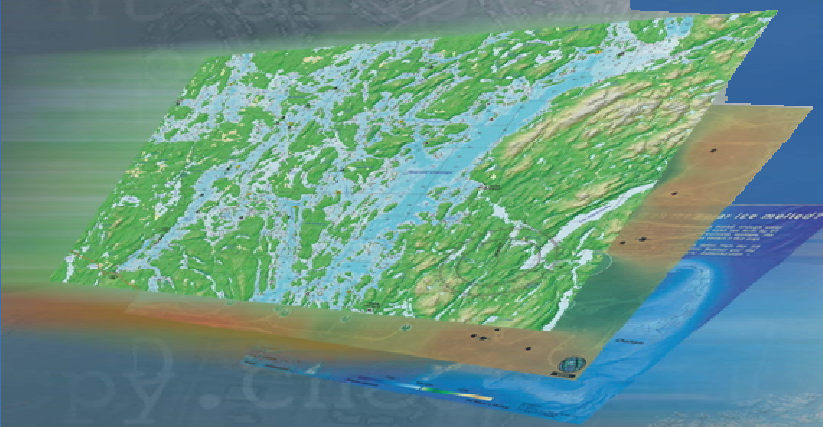
ArcPy 101



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What is ArcPy?

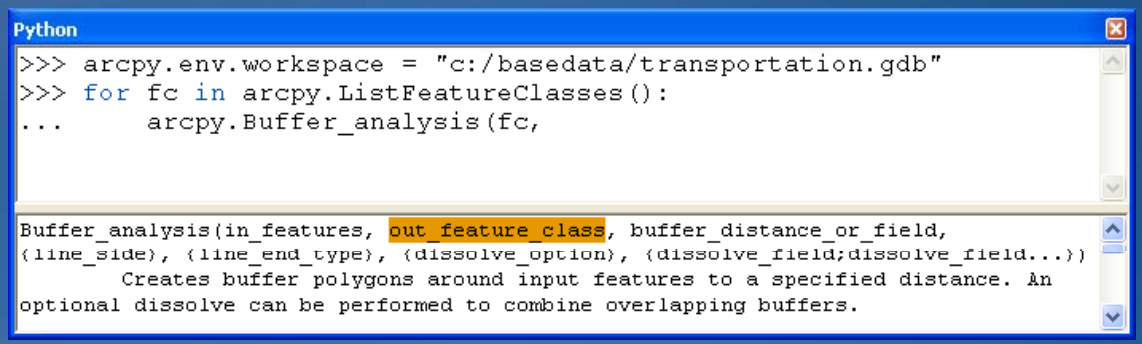
- A cornerstone for automation in ArcGIS
  - data analysis
  - data conversion
  - data management
  - map automation
- ArcPy is a native Python site-package
  - Access to 800+ geoprocessing tools
  - Provides embedded reference documentation for each function, class and module
  - Code completion for ArcGIS components in your favorite Python editor
  - Familiar to arcgisscripting users

ArcPy improvements

- Improved coding experience, such as:
  - Cursors
  - Classes
  - Multi-value parameters can be expressed as Python lists
  - Ability to convert rasters to and from NumPy arrays
- ArcPy is supported by modules, including:
  - A mapping module (arcpy.mapping)
  - A Spatial Analyst module (arcpy.sa) to support map algebra
  - A Geostatistical Analyst module (arcpy.ga)

What is the Python window?

- An embedded Interactive Python window within ArcGIS
  - Can access ArcPy, including tools and environments
  - Can access any other Python functionality,
  - Better code completion and intelligence
- The Python window is for:
  - Testing ideas
  - Experimenting with and learning Python
  - Simple execution of tools
  - Building quick and easy workflows in Python

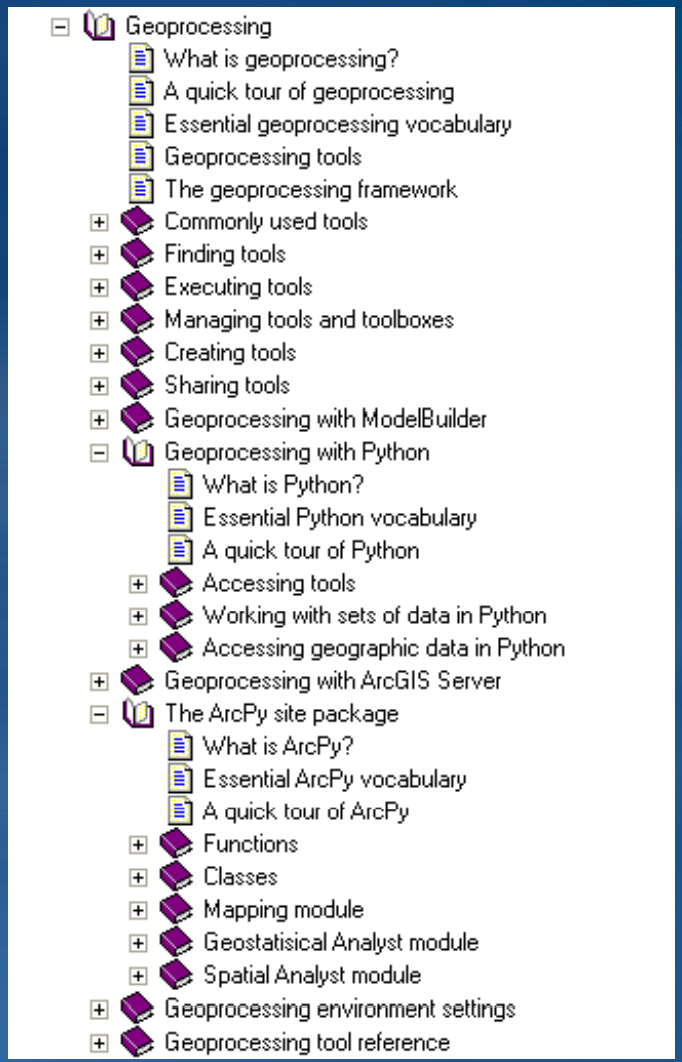


Demo:
A tour of ArcPy
and
the Python window

Getting more help

- **Desktop help**

- **Resource Center**
  - **http://resourcesbeta.esri.com/content/geoprocessing**



Running tools

- Tools are accessed as functions on arcpy
- Environments as properties from arcpy.env class

```
# ~~~ PYTHON CODE ~~~
import arcpy

# Set the workspace
arcpy.env.workspace = "c:/st_Johns/GISData.gdb"

# Execute Geoprocessing tool
arcpy.Intersect_analysis(["roads","urban_area","urban_roads",
                          5, "join")
```

Environments

- Script writers set the environment and tools use it
  - General settings
    - Current Workspace, Output Spatial Reference, Extent
  - Raster analysis settings
    - Cell Size, Mask
  - Many more

arcpy.env.workspace
arcpy.env.outputCoordinateSystem
arcpy.env.extent
arcpy.env.cellSize
arcpy.env.mask

Tool messages

- Executing a tool will produce 3 types of messages.
  - Informative messages (severity = 0)
  - Warning messages (severity = 1)
  - Error messages (severity = 2)

```
# start try block
try:
    arcpy.Buffer("c:/ws/roads.shp", "c:/outws/roads10.shp", 10)

# If an error occurs when running a geoprocessing tool,
#   print the tool messages
except arcpy.ExecuteError:
    print arcpy.GetMessages(2)

# Any other error
except Exception as e:
    print e.message
```

Functions

- Functions perform useful scripting tasks
  - Access geoprocessing tool messages (GetMessages)
  - List data to for batch processing (ListFeatureClasses, ListFields, nine other List functions)
  - Retrieve a dataset's properties (Describe)

```
import arcpy

# Set the workspace for ListFeatureClasses function
arcpy.env.workspace = "c:/test"

# For each fc, create a scratch name and clip
for fc in arcpy.ListFeatureClasses():
    outName = arcpy.CreateScratchName("clipped_" + fc,
                                      "", "featureclass",
                                      arcpy.env.workspace)
    arcpy.Clip_analysis(fc, "boundary", outName)
```

Describe

- Returns an object with dynamic properties
- Allows script to determine properties of data
  - Data type (shapefile, coverage, network dataset, etc)
  - Shape type (point, polygon, line, etc)
  - Spatial reference
  - Extent of features
  - List of fields
- Logic can be added to a script to branch (if statement) based data properties

Describe

```
# Describe a feature class
d = arcpy.Describe("c:/base.gdb/rivers")

# Branch based on the
# input's ShapeType property
if d.shapeType == "Polygon":
 arcpy.FeatureToLine_management(inFC, outFC)
else:
 arcpy.CopyFeatures_management(inFC, outFC)
```

Classes

- Most tool parameters can be easily defined
  - Such as a path or buffer distance
- Some parameters cannot be easily defined with a string
  - Such as a spatial reference or field mapping
- Classes can be used to define parameters

```
prjFile = "c:/North America Equidistant Conic.prj"

# Create a spatial reference using a projection file
spatialRef = arcpy.SpatialReference(prjFile)

# Run CreateFeatureclass using the spatial reference
arcpy.CreateFeatureclass_management(inputWorkspace,
     outputName, "POLYLINE", "", "", "", spatialRef)
```

Cursors

- Cursors allows
  - Iteration over the set of rows in a table
  - Ability to insert new rows into a table
  - Geometry access
- Cursors have three forms
  - Search, Insert and Update

```
import arcpy

# Print road name and road type
for row in arcpy.SearchCursor("D:/data.gdb/roads"):
    print “Road name:” row.roadname
    print “Road type:” row.getValue(“roadtype")

del row
```

Demo:
Converting GPS in XML
to useable Geographic data

A note on Cursor functions

- ArcPy cursors support iteration

At 9.3

```
rows = gp.SearchCursor(myTable)
row = rows.next()
while row:
    print row.GetValue("Rank")
    row = rows.next()
```

At 10

```
for row in arcpy.SearchCursor(myTable)
   print row.GetValue("Rank")
```

Insert Cursor

- Cursors support creation of new geometries

```
# Open an insert cursor for the feature class
cur = arcpy.InsertCursor(fc)

# Create array and point objects
ptList = [arcpy.Point(358331, 5273193),
          arcpy.Point(358337, 5272830)]
lineArray = arcpy.Array(ptList)

# Create a new row for the feature class
feat = cur.newRow()

# Set the geometry of the new feature to the
#  array of points
feat.Shape = lineArray

# Insert the feature
cur.insertRow(feat)

# Delete objects
del cur, feat
```

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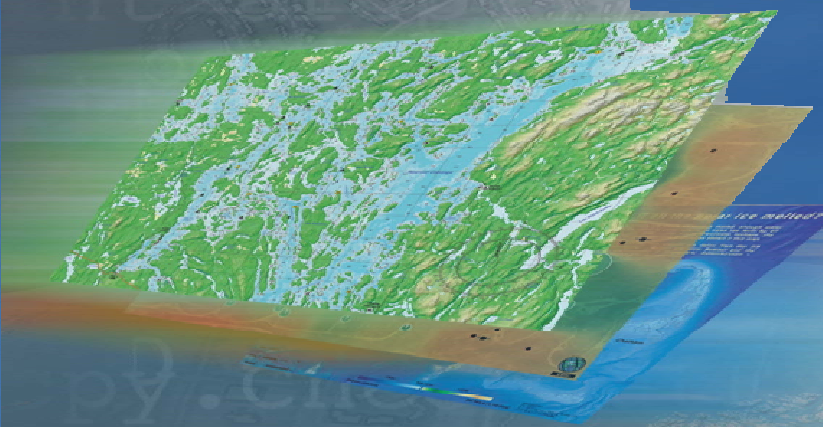
Creating Python script tools



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Placeholder—building script tool stuff

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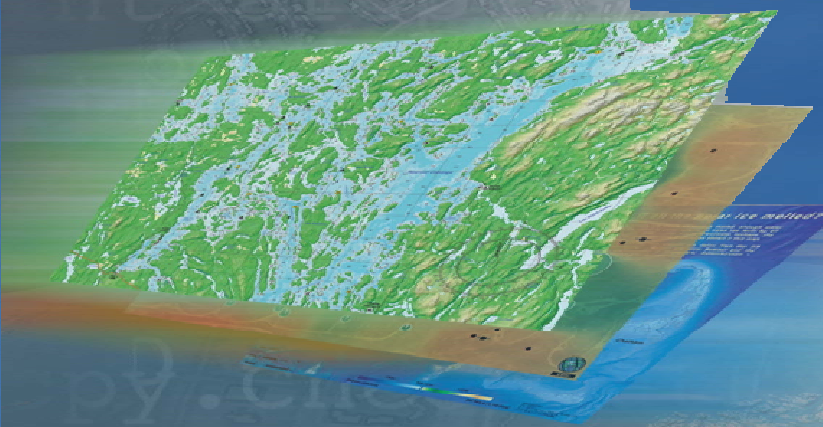
arcpy.mapping



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arcpy.mapping module

- A new mapping module that is part of the Geoprocessing ArcPy site-package
- A python scripting API that allows you to:
  - Manage map documents, layer files, and the data within
    - Find a layer with data source *X* and replace with *Y*
    - Update a layer's symbology across many MXDs
    - Generate reports that lists document information
      - Data sources, broken layers, spatial reference, info, etc.
  - Automate the exporting and printing of map documents
  - Automate map production/map series

- **Modify map document properties, save changes to a layer file, save changes to the map document**

```
import arcpy
mxd = arcpy.mapping.MapDocument("input.mxd")
df = arcpy.mapping.ListDataFrames(mxd)
df.scale = 24000
df.rotation = 2.7
for lyr in arcpy.mapping.ListLayers(mxd):
    if lyr.name == "Landuse":
        lyr.visible = True
        lyr.showLabels = True
        lyr.saveACopy("output.lyr")
mxd.save()
del mxd
```

Demo:

Map automation tools

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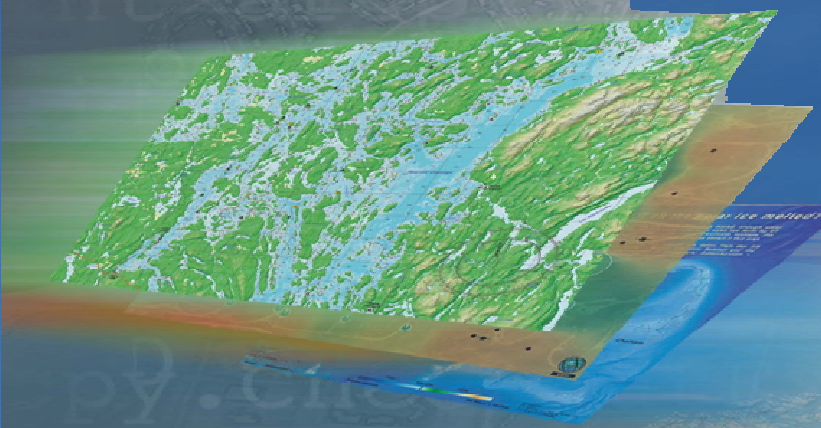
BREAK!

See you at 10:45



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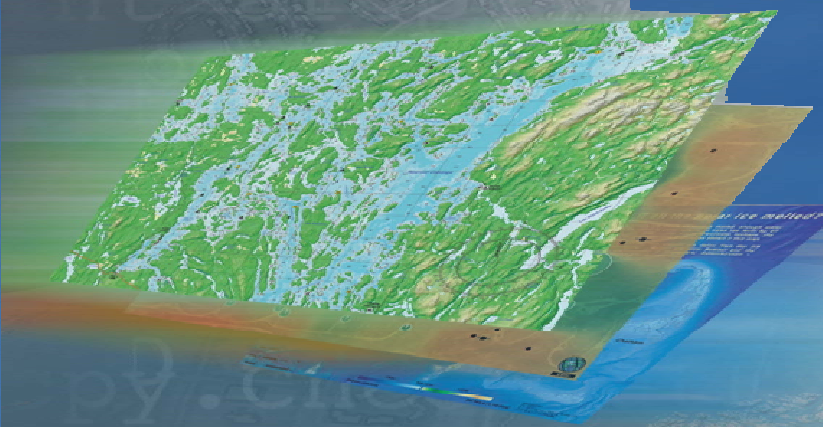
Raster analysis and Map Algebra



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Raster class

- Returned output from Spatial Analyst tools
  - Used to represent a raster dataset on disk
  - Can be used as inputs to tools and Spatial Analyst Map Algebra expressions
- Supports operators (or arithmetic operations in Map Algebra expressions)
- Has properties and methods for analysis
  - raster.min
  - raster.max
  - raster.save()

Spatial Analyst module

- Spatial Analyst module that integrates Map Algebra into Python
  - Includes all Spatial Analyst tools
  - Supports operators in Map Algebra expressions
  - Helper classes that can be used to support complex parameter
  - Output on the left-side

```
from arcpy.sa import *
demm = Raster("DEM") / 3.28
slpdeg = Slope(demm, "DEGREE")

demfs = FocalStatistics("DEM", NbrRectangle(3,3), "MEAN")
```

Raster Integration

- NumPy is a 3rd party Python library for scientific computing
  - A powerful array object
  - Sophisticated analysis capabilities
- ArcPy Raster objects can be converted to NumPy arrays for analysis
  - RasterToNumPyArray(), NumPyArrayToRaster()

```
inras = "ras100"

# convert raster to Numnpy array.
rasArray = arcpy.RasterToNumPyArray(inras)

# ARRAY SLICING: get the total sum of every third value
#  from every third row of the  raster
sampArray = rasArray[::3,::3]
sum = NUM.sum(sampArray)
print sum
```

Demo:
Working with Map Algebra and NumPy

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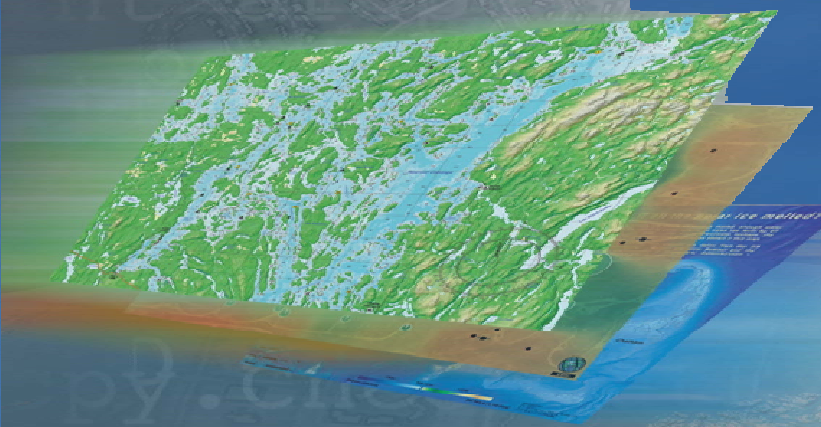
Tool Design and Validation



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Dale’s script tool wizardry – validation