DRAFT

Deploying Python tools to GIS users

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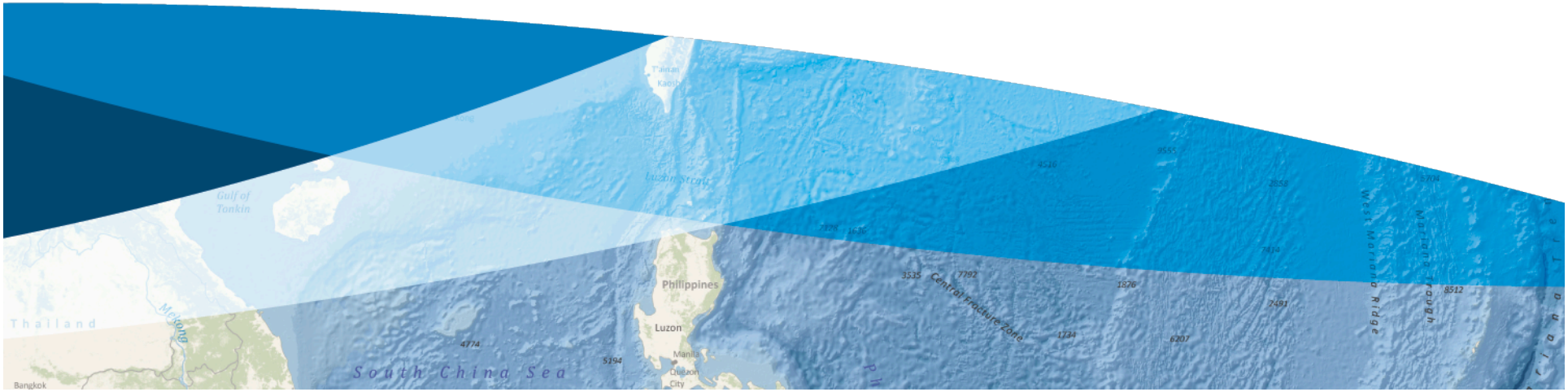
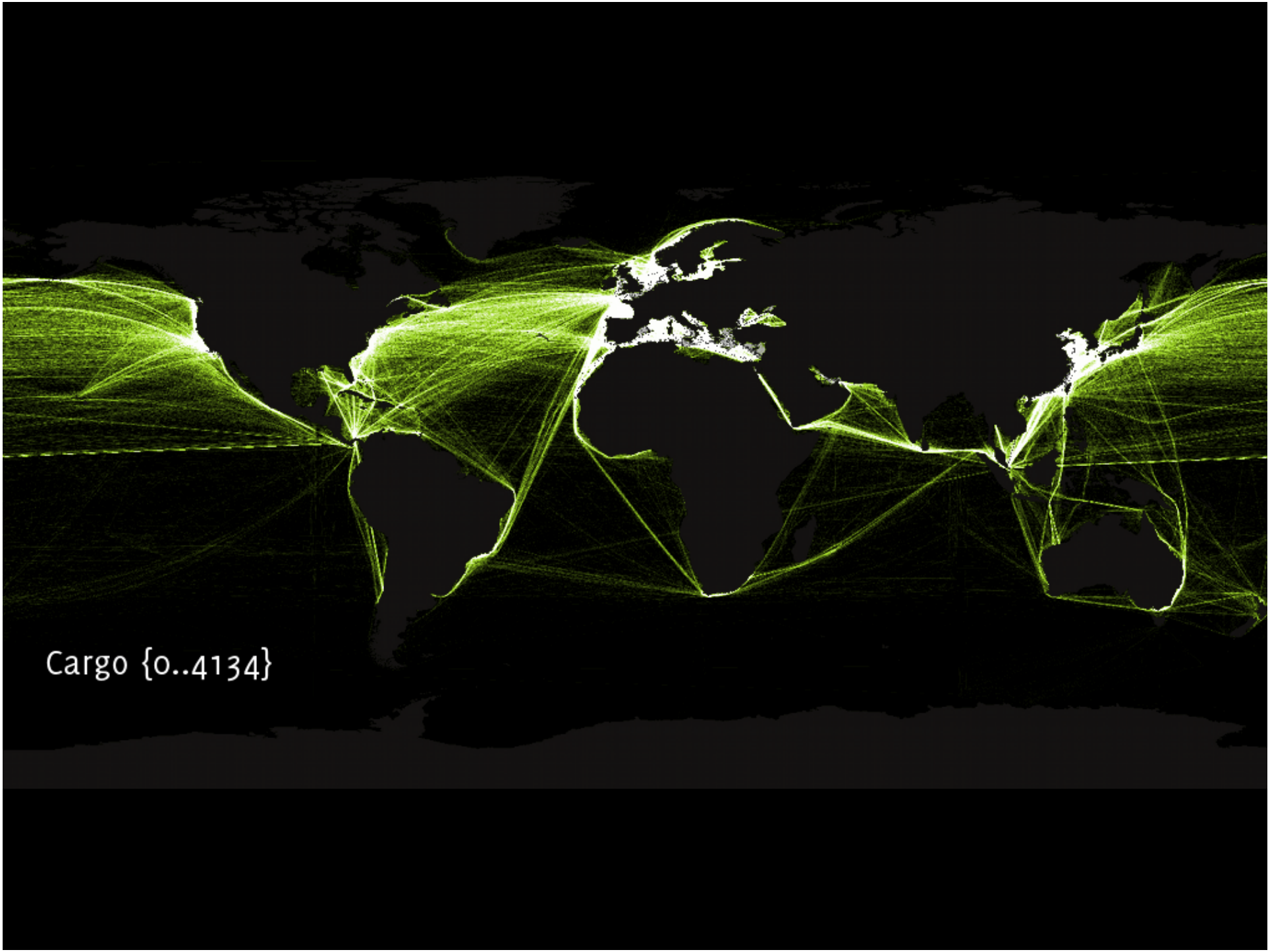
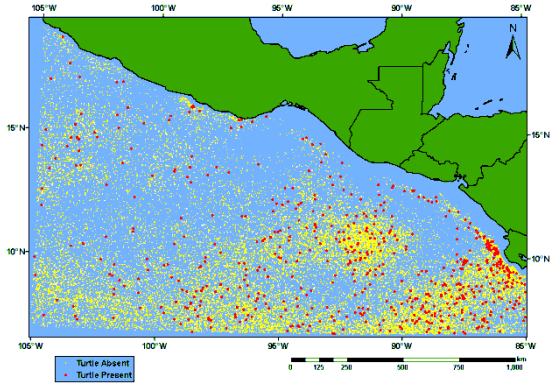
https://github.com/scw/scipy2014-talk



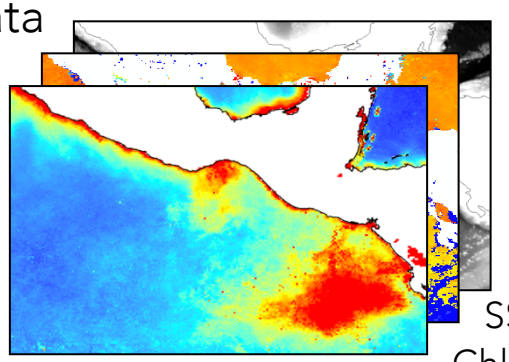

Cargo {0..4134}

BTM output into a predictive model (e.g. MGET)

Point observations of species



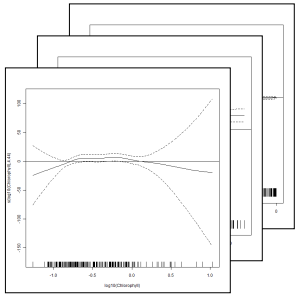
Gridded environmental data

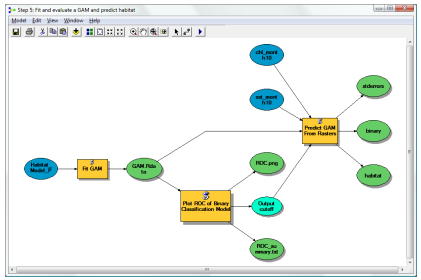


Bathymetry
SST
Chlorophyl

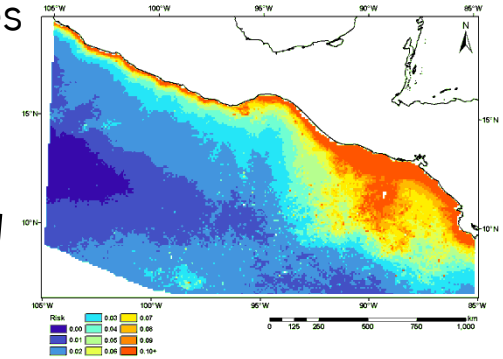
Predictive model

$$g(\mu) = \beta_0 + \beta_1 x_1 + \cdots + \beta_m x_m$$

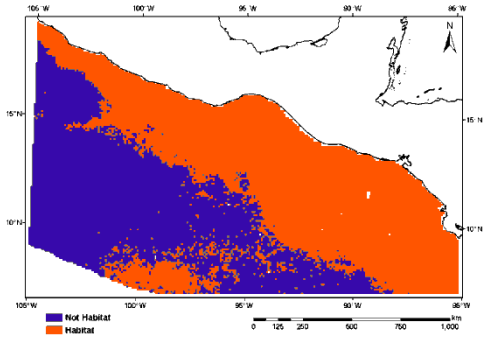


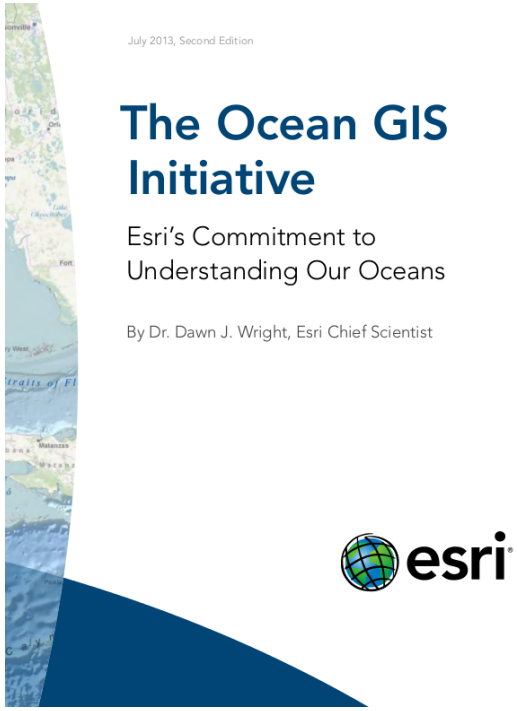


Probability of occurrence predicted from environmental covariates



Binary classification





- Dawn Wright: my boss / awesome person
- Building up ocean science as a core part of what Esri does
- Part of broader Esri efforts to support the needs of ocean science – ocean basemap, multidimensional support, vertical datums, improving ArcGIS for scientific needs

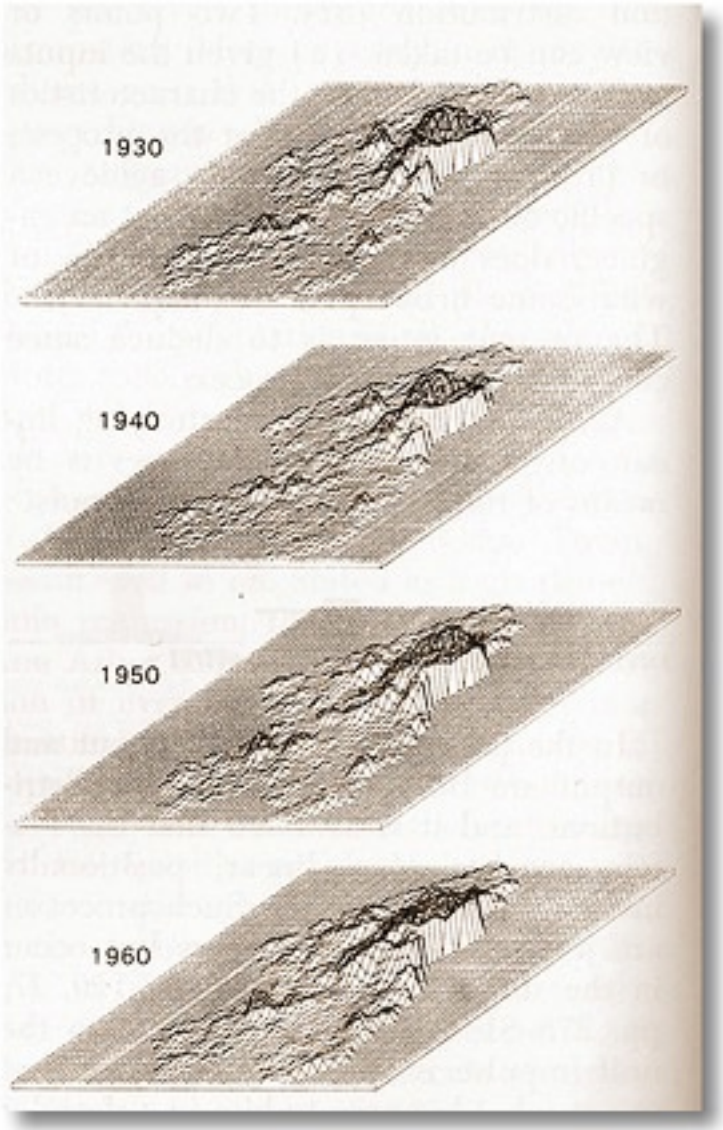
DESIGN WITH NATURE

IAN L. MCHARG

25th anniversary edition

Representing Spatial Objects

- Continuous fields (raster)
  - Regular (GeoTIFF)
  - Irregular (Finite Element Model)
- Vector
  - Non-planar (Shapefile, GeoJSON)
  - Topological (E00, TopoJSON)
- Network
- Move between objects and a dimensional space:
  - 0D: Point
  - 1D: Line
  - 2D: Area
  - 3D: Solid
  - 4D: Space-time

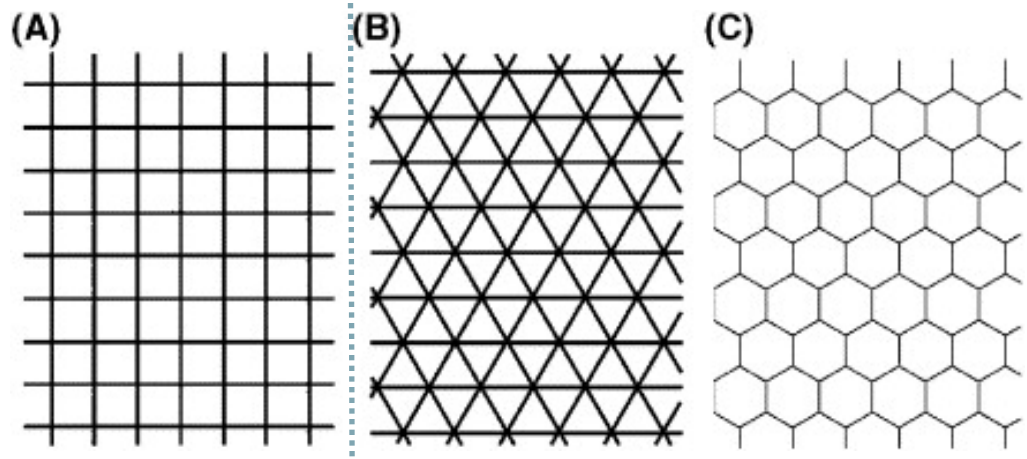


How broadly used are the models?

Choices	Percentage
Simple Vectors (points, lines, areas)	*91.30%*
Rasters	*73.91%*
Vectors which include time or measures	*60.87%*
Point clouds (e.g., LiDAR)	*34.78%*
Raster Catalogs	*34.78%*
Raster Mosaics	*26.09%*
Multidimensional Data Structures (e.g., NetCDF, HDF)	*21.74%*
Other	
Irregular Grids	*17.39%*
Other	*13.04%*
Mesh Volumes	*8.70%*

Tessellations

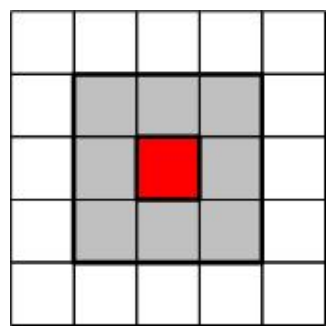
Descartes and friends



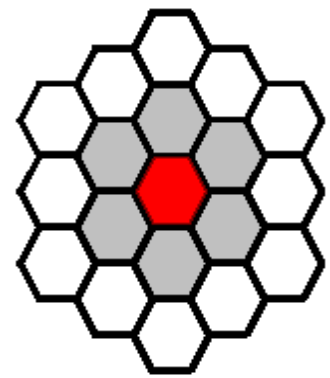
Neighborhoods

Focal operators

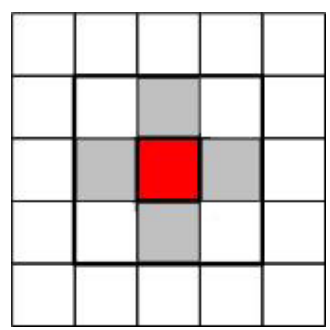
Can also use Zonal operations (use features for zones)



Moore, *r*=1



Hexagonal, *r*=1



Von Neumann, *r*=1

Background on GIS

- Software implementations preceded science (in contrast with fields like statistics)
- Blends both art and science in a cohesive model

- Modeling
- Prediction (geostatistics)
- Analysis (spatial statistics)
- Design
- Visualization

Chicago Transportation (1959)

FIGURE 7—TOTAL PERSON TRIP DESTINATIONS

The destinations of 10,212,000 person trips, on the average weekday, are distributed throughout the Study Area as shown in this model. The highest blocks in the model represent 144,000 trip destinations per quarter square mile grid, the lowest blocks 5,000, the shaded areas less than 5,000 but more than 2,500.

Open Source Tools

- Primarily programmer- and CLI- oriented (e.g. GDAL, Proj.4, GEOS, R Spatial)
- Great area of growth, want to bridge these tools to a lay audience who use GIS in existing complex workflows
- Hybrid solutions are common (commercial APIs + FOSS, FOSS + PAS, …)

GDAL PostGIS R GEOS Geometry Engine Open Source

Why GIS

- Many more people want to use spatial thinking than there are programmers – domain experts, not computer scientists
- Desktop GIS broadly is used, want to reach these users with tools we develop
- GUI driven with command line (CLI) + API for experts
- However: Exciting things happening on the web! (tiled maps, d3, APIs, JavaScript-for-everything)

Why ArcGIS

- ArcGIS was polled as #1 tool used for scientific analysis at the 2011 USGS Community for Data Integration Workshop (ArcGIS:65%, Open Source GIS:12%, Python:8%, Matlab:5%, R:5%, Other:5%)[1]

1. Courtesy Rich Signell, USGS Woods Hole

Existing Extensions

- MGET (Duke University): Integrates R, Python, MATLAB
- GME: R and statistical analysis
- CircuitScape: graph-based movement
- LASTools: LIDAR processing
- Benthic Terrain Modeler: geomorphology
- Esri2Open: export features to web-friendly formats (e.g. TopoJSON, SQLite)

ArcGIS Python Environment

- Python added as scripting language at ArcGIS 9.2 (2004), ships with every install
- Now can execute~80% of ArcMap (100% if you use `ctypes` to connect with Arc Objects)
- Continue to improve support and integration with python

ArcGIS Python Environment

Out of the box w/ ArcGIS:

python™

matplotlib

NumPy

`xlrd + xlwt` (10.2)
`netcdf4`

Simple Integration:

IP[y]: IPython
Interactive Computing

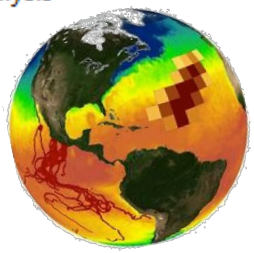
pysal
Python Spatial Analysis Library

SciPy

pandas

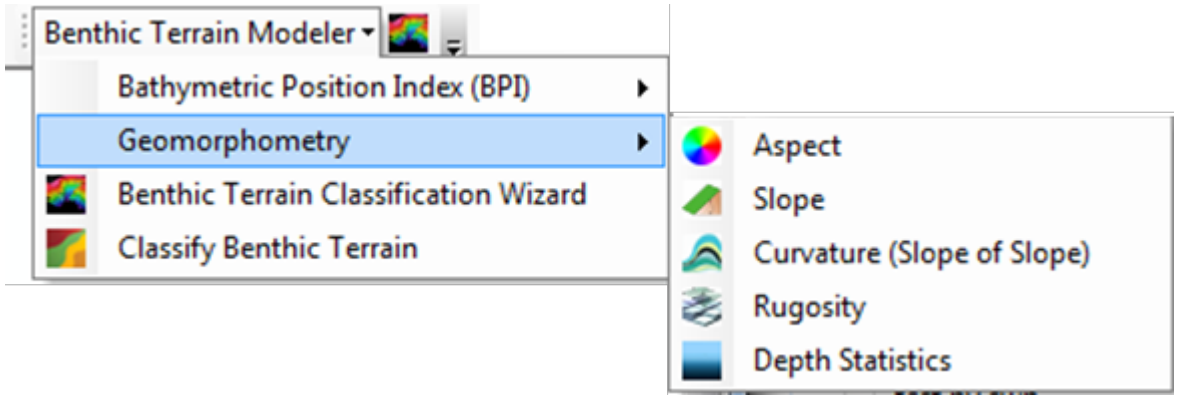
$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$

GDAL

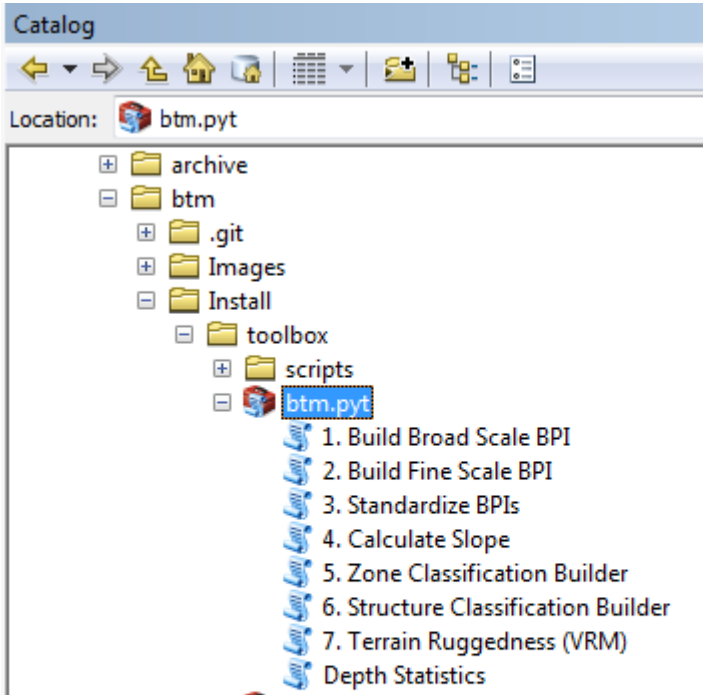


Extensions

Python Add-in

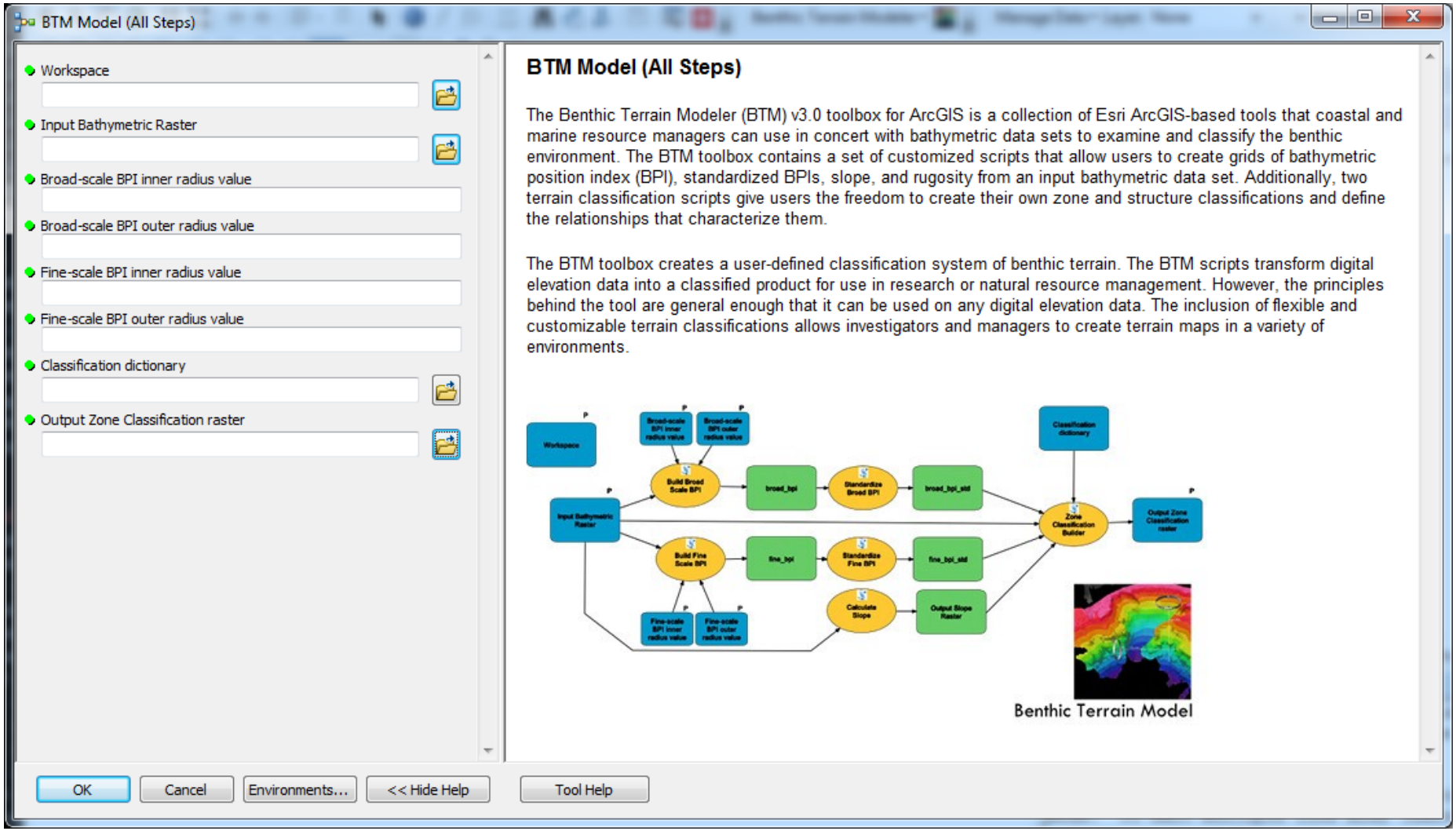


Python Toolbox



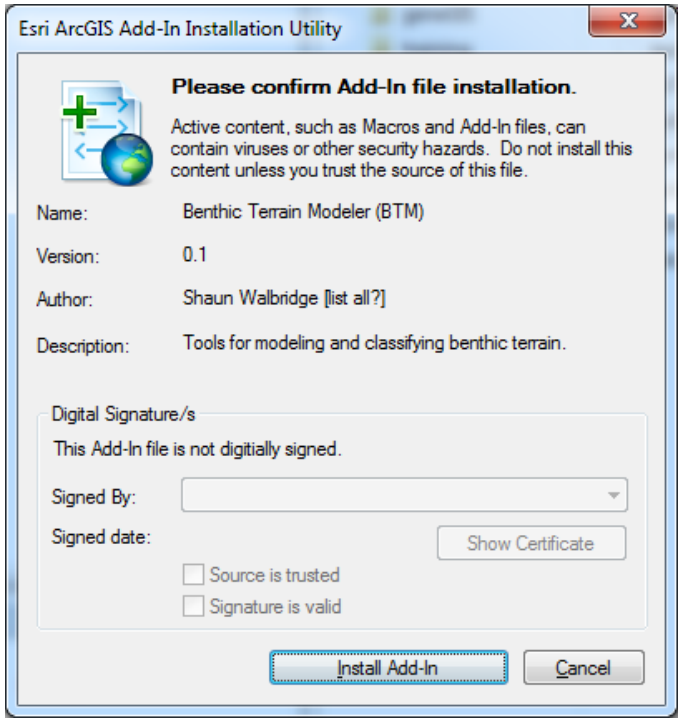
- Can be written in .NET or Python
- Here, focus on Python toolboxes and Add-ins (10.1+)

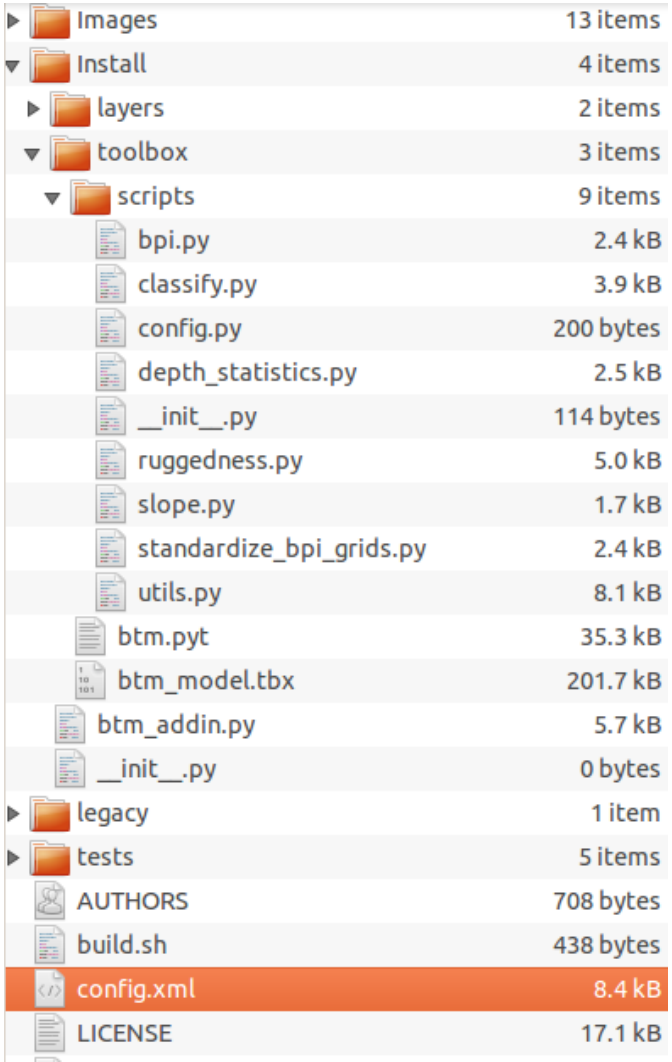
Combine tools in Models



Easy installation and creation

- Python scripts + Python toobox + layout XML
- Builds an installer

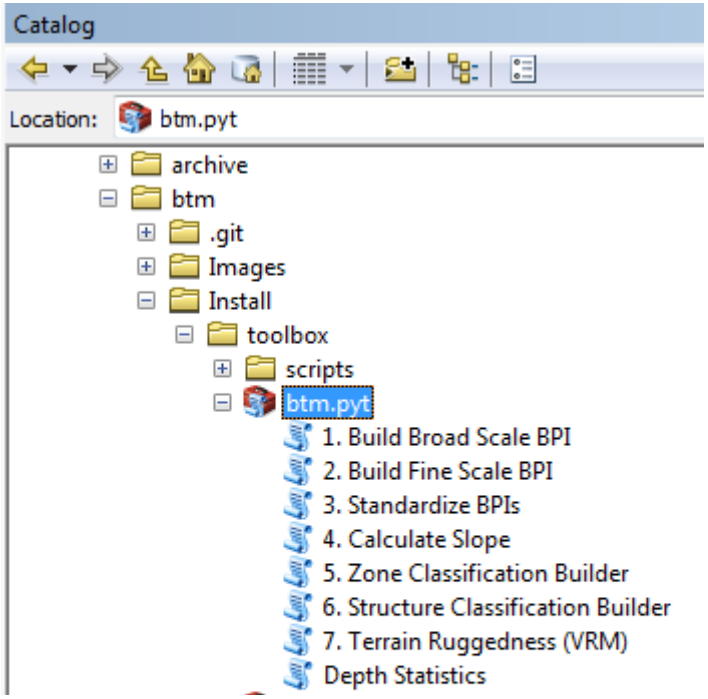




Python Toolboxes

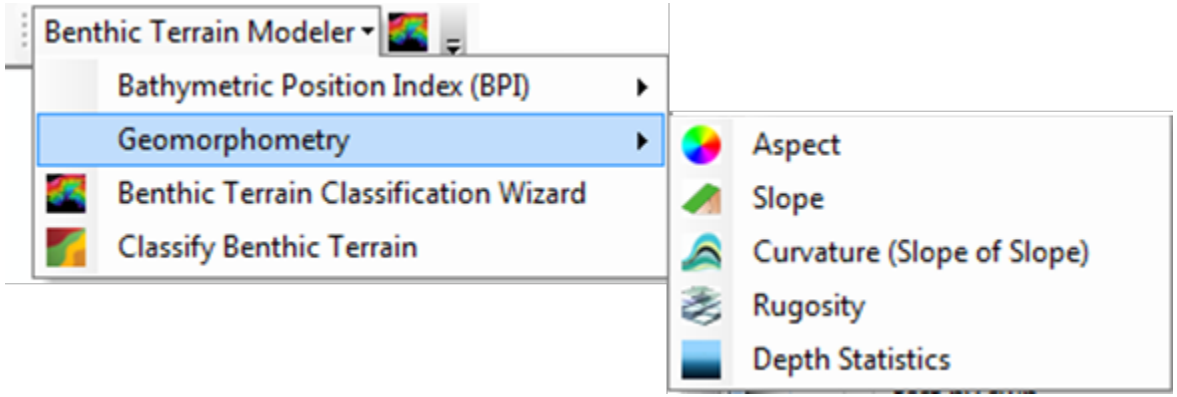
Create a Python class, and add one function per tool you'd like to create

Can embed the execution, or connect to another script

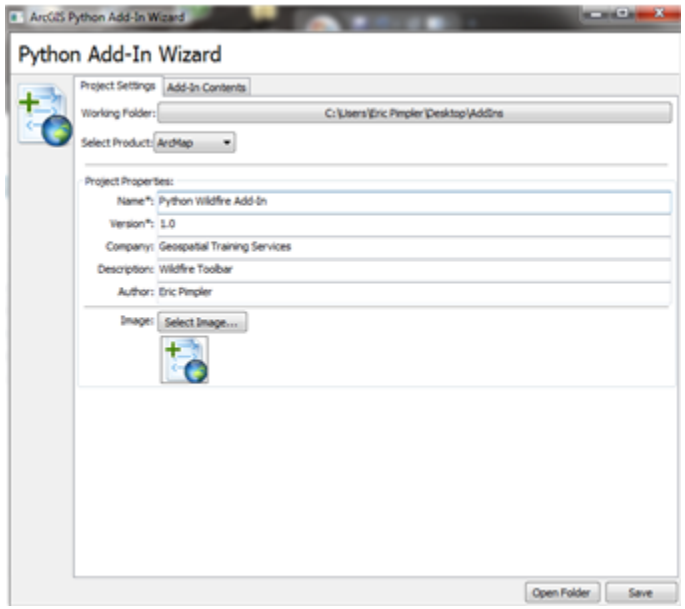


https://github.com/scw/scipy2014-talk/blob/master/maxent.pyt

Python Add-in



Buttons
Tools
Combo Boxes
Menus
Toolbars
Tool Palettes
Application Extensions



Will post full code example

- https://github.com/scw/scipy2014-talk/
- Show both the model and add-in, and provide instructions on its creation
- Help move GIS users toward maintainable, reusable code and beyond the "one-off" code mentality

DRAFT

Thank You

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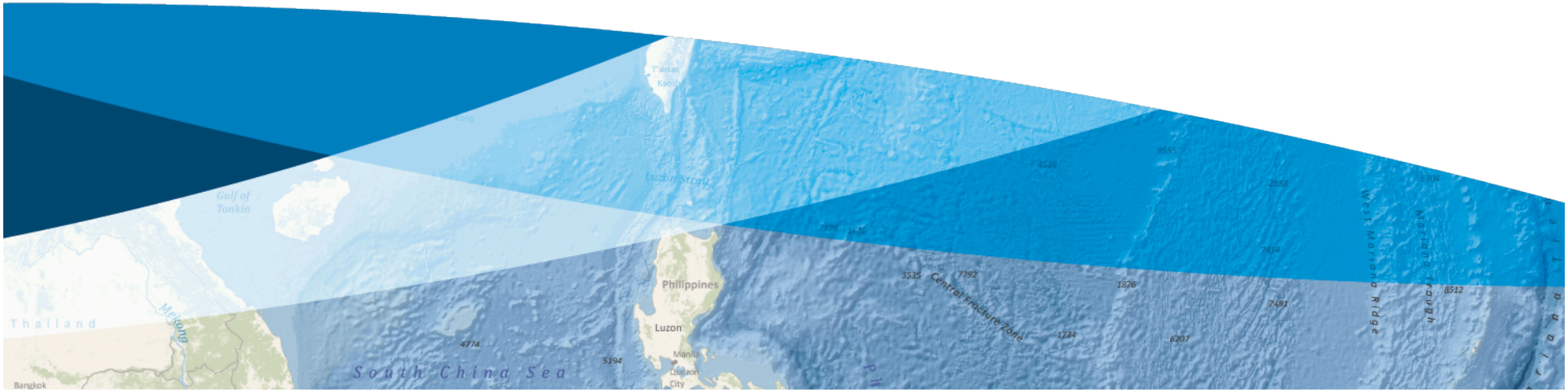
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