Professional Python Development in ArcGIS Pro

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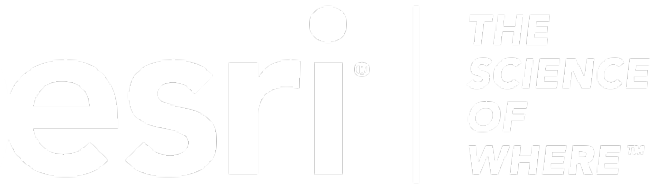
High Quality PDF (2MB)

Introduction

Intro

About me: - Product Engineer - Geoprocessing at Esri (1 year 8 months) - Python - ArcPy - Conda Integration - C#/WPF - Python Backstage - Charts and Graphs - Presentations - Previously a GIS Developer at Matrix Solutions in Calgary - Civil Engineering/Environmental Consultant Firm - Created several dozen custom Geoprocessing tools in Python - Customized ArcGIS with Python and C#/WPF

Esri ArcGIS



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Setting up ArcGIS Pro

- **Windows Only**
- Free Windows VMs
- (http://bit.ly/FreeWindowsVM)
- Free ArcGIS Pro
- (http://bit.ly/ArcPyProTrial)
- ArcPy Documentation
- http://bit.ly/ArcPyDocs

Why ArcGIS?

- Powerful and Proven technology
  - ARC/INFO released in 1982
  - ArcGIS in 1999
  - ArcGIS Pro in 2015
- Extensive Python Support:
- ArcPy
- ArcGIS Python API
- Second-to-None Documentation
- Esri Blog
- Esri Press
- ArcGIS Help
- Supports multiple GIS Applications
- ArcGIS Desktop
- ArcGIS Enterprise
- ArcGIS Online
- Rich source of GIS Data

- ArcGIS Online provides thousands of ready-to-go datasets.
- Large selection of Plugins
- https://marketplace.arcgis.com/
- Included suite of cartographic symbology.
- Industry Standard solution - Used by Governments, Fortune 500 companies and Individuals.
  - Swiss Gov't examples (Canton Governments, Swiss Institute of Forest, Snow and Landscape Research etc)

Why ArcGIS Pro?

Modern View for ArcGIS:

- .Net 4.5 concurrency model
- Integrated 2D and 3D views
- In active development, New Features
- Modern Python Experience
- Supports environments and packages via Conda

Figure 1:

Python Packages and Environments

Package Management on Windows

Using `pip`, wheels, virtualenvs - Packaged with distributions of Python - These tools handle the harder problem of system dependencies, considered out of scope by Python packagers — does it end up in `site-packages`? - Package devs: On OSX and Linux, 'easy' to get the deps! Use a system package manager (e.g. `apt`, `brew`, `yum`) and the included compiler (e.g. `clang`, `gcc`).

Virtual Environments

What are Virtual Environments - Self-contained instances of Python - Seperate from main Python installation - Can contain a unique set of packages - Useful when working on multiple projects at one time

What about Windows?

- We are particularly stuck on Windows which lacks broadly used package management
- Only developers have a C compiler on their machine (Typically Visual Studio)
- A hard problem for many organizations to reliably solve
- "Works on my machine but not yours" problem.
- Supporting users takes up valuable dev time
- No guarantee that customers will be supported

Enter Conda

Why Conda?

- Scientific Python community identified that there was a gap not being addressed by the core Python infrastructure, limiting their ability to get packages into the hands of users
- Industry standard built by people who care about this space — Continuum Analytics
- Handles dependencies for many languages (C, C++, R and of course Python)
- Built for Python first, but it really solves a much broader infrastructural issue.

Conda in ArcGIS Pro

Significant effort has been made at Esri to integrate the conda package manager and virtual environment experience into the ArcGIS Pro experience. - Shipped with environ-

ment support - In-app user interface - Packaging effort for Esri Python code

Using Packages to our Advantage

Open Source Ecosystem

- The Python Ecosystem includes thousands of open-source packages
- Esri is using several packages
- NumPy
- SciPy
- matplotlib
- Pandas
- Automate or Extend your ArcGIS capabilities
- Easily package and share your work

Setting up a Development Environment

- What can we install? Not just scientific packages.
- Documentation
- Datasets
- GUI toolkits (PyQt, TKinter)
- Database Drivers (psycopg2)
- C++ Libraries (Boost)
- IDEs (Spyder, Juptyer)

Working with Customers

Requirements Analysis

Determining user expectations for a new or modified product - Identify Stakeholders - Eliciting Requirements - Stakeholder interviews - Ethnography - Analyzing Requirements - Clear - Complete - Consistent - Recording Requirements - User Stories - Use Cases

Test Driven Development

Turning valid requirements into testable code - Identifying units of work - Defining functional extent of units - Writing tests to encapsulate functionality

Efficient Testing with ArcPy

Extra considerations for Geospatial tools - Data set types - Projections - UI interactions

Version Control as a Communication Tool

What is Git?

A distributed version control system. - Originally made for linux developers - Arguably the most popular open-source version control - Heavily used in Conda packaging workflow

Why Git?

Features of Git that support Conda packaging - Commit hash as version number - Natively supports cross-language projects - Packages can 'cherry-pick' parts of repos - Also can aggregate multiple repos

What is Github

Github promotes ‘Social Coding’ a combination of Version Control and Social Media - Ease of Collaboration - Ease of Communication - Ease of Distribution Esri on Github - https://www.github.com/Esri - https://www.github.com/arcpy

Github as a Communication Tool

Github offers several features which enhance communication - Issue tracking - Tags - User Notifications - Repository Forking

Creating Tools in ArcGIS Pro

TBX Toolboxes

The original ArcGIS toolbox. - Created via the ArcGIS GUI - Tool Validation not set in Python script - Set via ‘Properties’ menu of tool in ArcGIS - Out of scope for this Presentation

Python Toolboxes

ArcGIS toolboxes revisited in Python - All steps defined in a .pyt file - Validation defined within script - Works with Python IDEs - Define .pyt as a Python filetype in settings - Toolbox Class - **init** - self.tools - Tool Class - **init** - Validation - Logic

Tool Validation

ArcGIS Supports Dozens of Data Types - Ensure the inputs supplied by the user are valid - Dynamically populate fields with values - Inform users when unexpected or unusable data is present

Input/Output Parameters

Defining Parameters Working with Input Parameters - GetInputParameter - GetInputParameterAsText - Parameters from Command Line Working with Output Parameters - Schema - ParameterDependencies

getParameterInfo

Populate the values of a Tool's Parameters - Called when the tool is opened. - Populate input parameters with inital values

updateParameters

Refine and Modify the values of a Tool's Parameters - Called whenever a parameter has been changed in the ArcGIS GUI - Frequent calls - Make method 'inexpensive' if possible - May use 'global' values to store results after first call

updateMessages

Modify the Messages created when a Tool's Parameters have changed - Called after validation has been performed. - Display a Warning or Error to users if Parameters have bad values

isLicensed

Query the license system to ensure the tool can run at the current license level. - Checking for licenses

execute

The tool's source code which is run upon tool execution. -

Tool Logic

Where the Geoprocessing of data is accomplished - This is the only part of the code which should call Geoprocessing Tools - Returns either a dataset or a status code - SetSeverityLevel - SetOutputParameter

Modular Design

Validation modules

For each validation requirement: - Create a function which will validate a dataset - Create a dataset which satisfies the validation requirements - Create one or more datasets which do not satisfy requirements - Write validation functions

Debugging/Testing Tool Validation

Creating tests for validation: - Validation accomplishes two things - Ensuring the data set is 'clean' - Ensuring the data set will not crash the tool - Two types of tests - Correct data does not trigger any errors - Incorrect data is error handled and returns a message

Planning the Logic of a Tool

For each requirement in a tool: - Create a function which accomplishes the requirement statement - Call the function from the applicable test method(s) - Commit when the code passes the test(s)

Granularity in Tool Design

Can we break a tool into multiple tools? - Does any requirement make sense as a standalone tool? -

Reusing Modular Code

Tool Metadata - Tags

Conda Environments

Development Environments

- Contains features in development
- May use alpha/beta code
- Contain test modules & data
- Mirrored by version control
- Contains packaging metadata
- bld.bat/bld.sh
- LICENSE
- Manifest.in
- meta.yaml
- README.md
- setup.py

Production Environments

- Stable environments in which to run tools/services
- Requires stable versions of packages
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Packaging Tools the Right Way

Creating a Package

Using setuptools and distutils to create a Python Package. - setuptools - setup - pkg_resources - distutils - Legacy, use setuptools if possible Creating a conda package -

conda-build - meta.yaml

Documenting a Package

Deploying a Package Internally

On a network Via a http server

Deploying a Package Publicly

Python Package Index Anaconda.org Custom Server

Viewing the Tool Output

Tools in ArcGIS Pro

Deploying a Tool as a Service

Consuming services via the ArcGIS Python API