ArcGIS API for Python

Experience ArcGIS in a Notebook

Ziad Siebaa
gistec

SEE WHAT OTHERS CAN'T

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Agenda

- ArcGIS API for Python
- Jupyter Notebook / Lab
- Demo (Deep Learning / Palm Detection Using ArcGIS API for Python)
- ArcGIS Notebooks
- Quick tour of ArcGIS Notebooks
- ArcGIS Notebook Real Samples
- Questions & Answers

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Python

Python is one of the most widely used programming languages. It is free, cross-platform, easy to learn and interpret, and can be applied to many disciplines.

Python was introduced to the ArcGIS community with ArcGIS 9.0.

ArcPy (Python 2.X)

ArcPy (Python 3.X)

Python + GIS use cases

Web GIS Administration

Content Management

Analysis and Data Science

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What is ArcGIS API for Python?

- Python library for spatial analysis, mapping and GIS
- Powerful, modern and easy to use
- Powered by Web GIS, with local capabilities

Made for AUTOMATION and DATA SCIENCE

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ArcGIS API for Python and ArcPy

ArcPy

- ArcGIS Desktop
  - ArcMap – Python 2.x
  - ArcGIS Pro – 3.x
- Mostly geoprocessing
- Some map automation

ArcGIS API for Python

- Script against a portal
  - ArcGIS Online or ArcGIS Enterprise
  - Python 3.x
- Analysis, Portal Admin, Content Creation, Big Data Analysis

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ArcGIS API for Python

- What can it do for you?

Platform API

Power Users
Developers

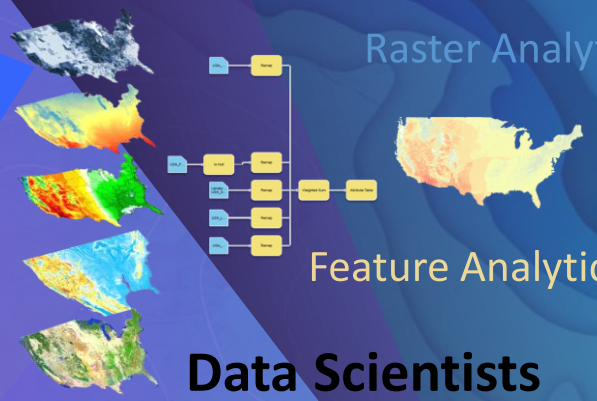
Spatial Analysis

Imagery

Location Analytics

Analysts

Big Data



Raster Analytics

Feature Analytics

Data Scientists

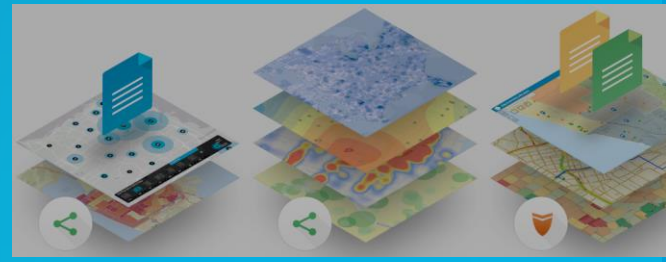
Enterprise Integration

Users, Roles & Group management

Administrators
DevOps

Your Web GIS

Content Publishers



Data Management

Script and automate your Web GIS

API Overview

arcgis Package

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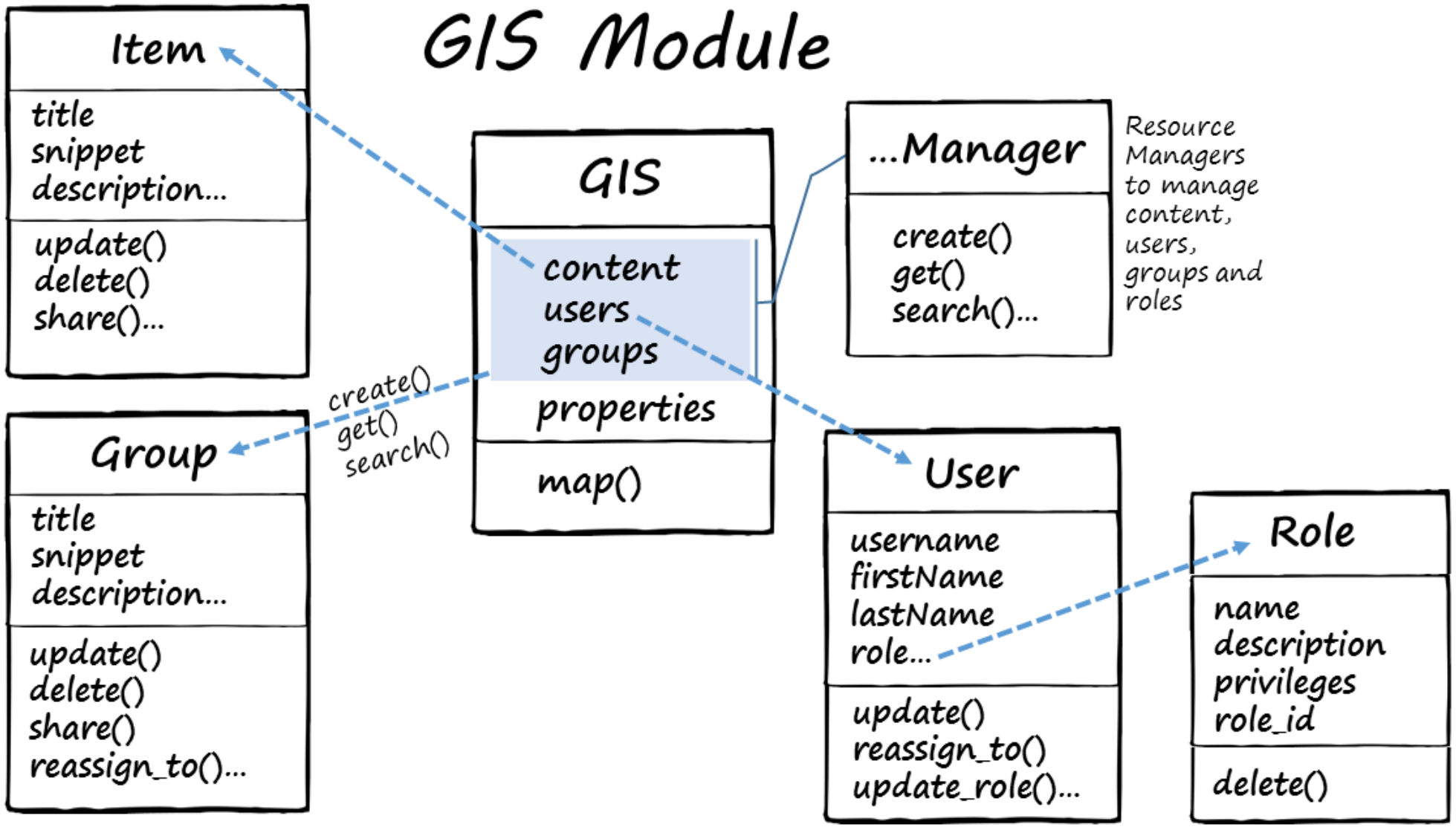
GIS Module



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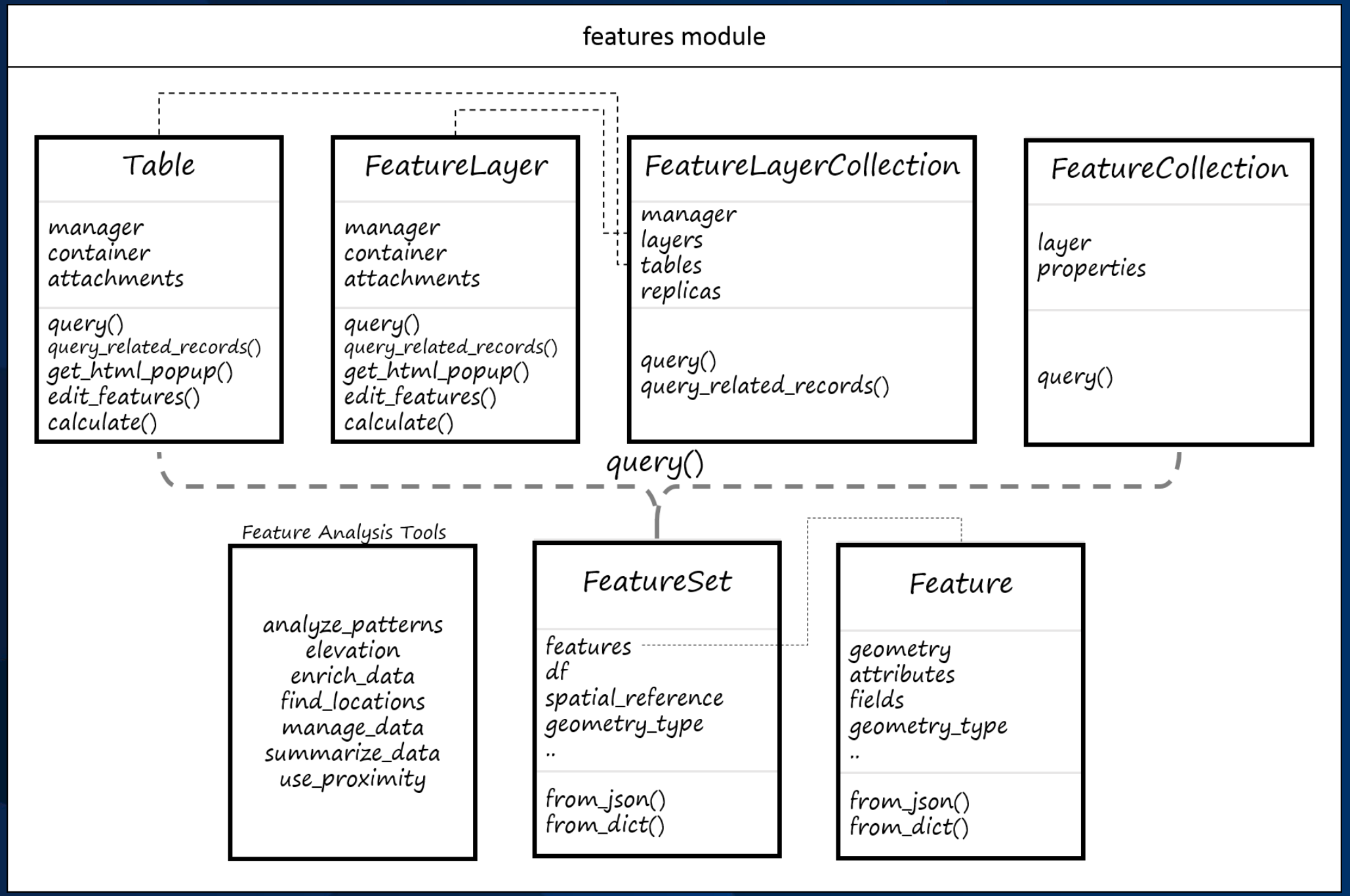
features module
Table
manager
container
attachments
query()
query_related_records()
get_html_popup()
edit_features()
calculate()
FeatureLayer
manager
container
attachments
query()
query_related_records()
get_html_popup()
edit_features()
calculate()
FeatureLayerCollection
manager
layers
tables
replicas
query()
query_related_records()
FeatureCollection
layer
properties
query()
query()
Feature Analysis Tools
analyze_patterns
elevation
enrich_data
find_locations
manage_data
summarize_data
use_proximity
FeatureSet
features
df
spatial_reference
geometry_type
..
from_json()
from_dict()
Feature
geometry
attributes
fields
geometry_type
..
from_json()
from_dict()

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How do I get “ArcGIS API for Python”?

- Try it Live! – https://notebooks.esri.com
- ArcGIS Pro 2.1 and later – included
- pip install arcgis
- conda install -c esri arcgis
- docker pull esridocker/arcgis-api-python-notebook

For More Details:

https://developers.arcgis.com/python/guide/install-and-set-up/

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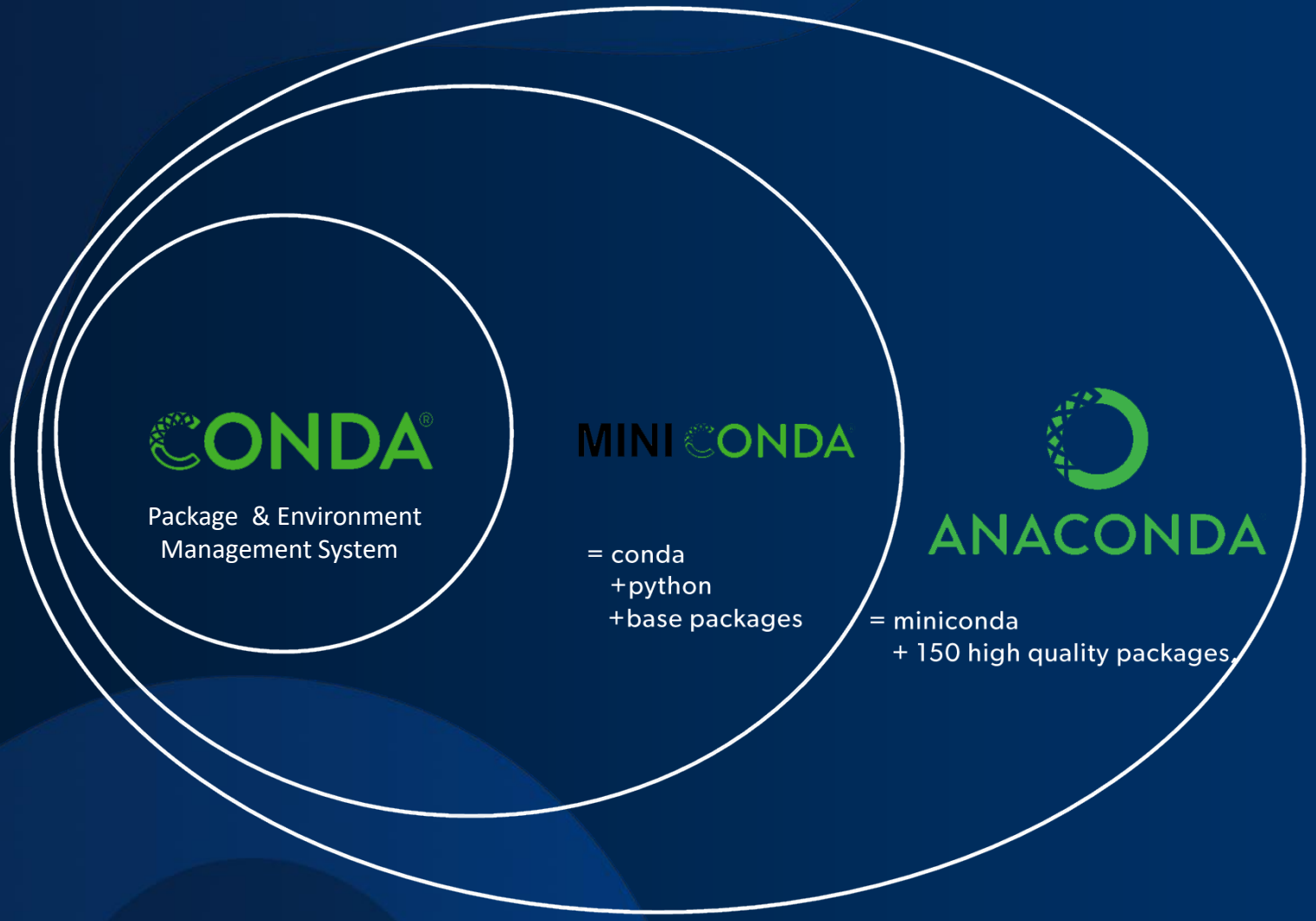
Differences between Conda, MiniConda, and Anaconda



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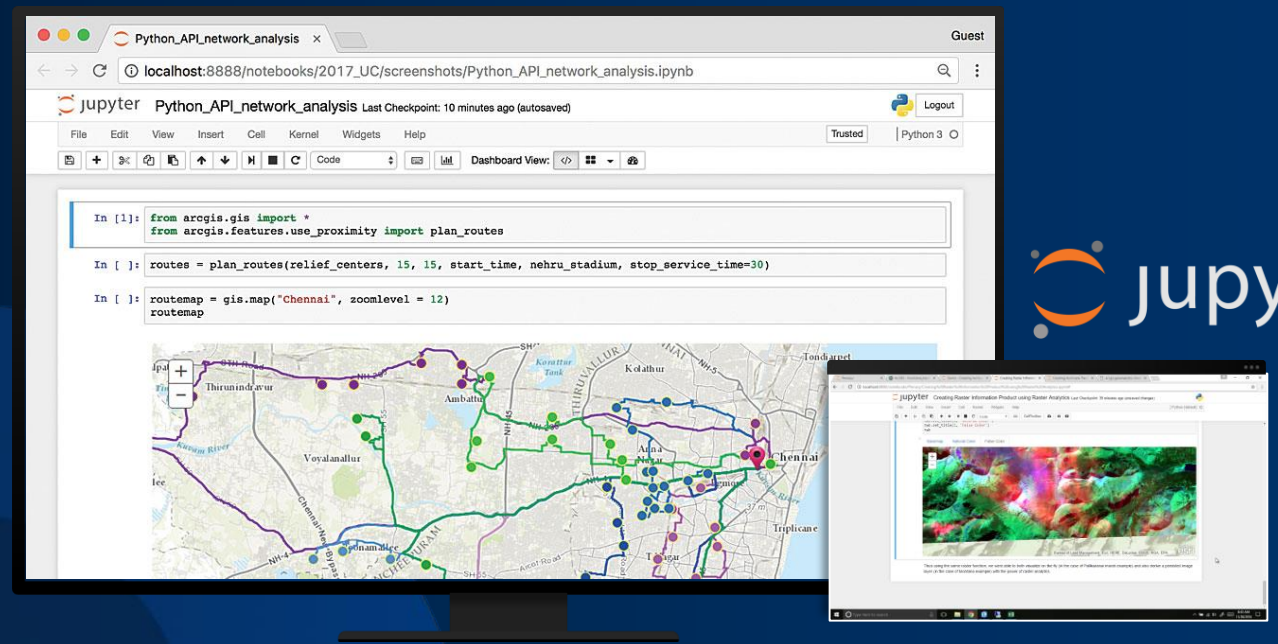
Python Jupyter Notebook

- It is a web-based, interactive, computational environment for you to write, document, and run code all in one place.
- Jupyter is a popular open source notebook environment
  - Jupyter gets its name from three programming languages: Julia, Python, and R
- The ArcGIS API for Python was developed to make the most of Jupyter's functionality.



jupyter

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ArcGIS + Jupyter = ❤

esri | chennai_floods_analysis (autosaved)

File Edit View Insert Cell Kernel Widgets Help | Python 3

Markdown | CellToolbar

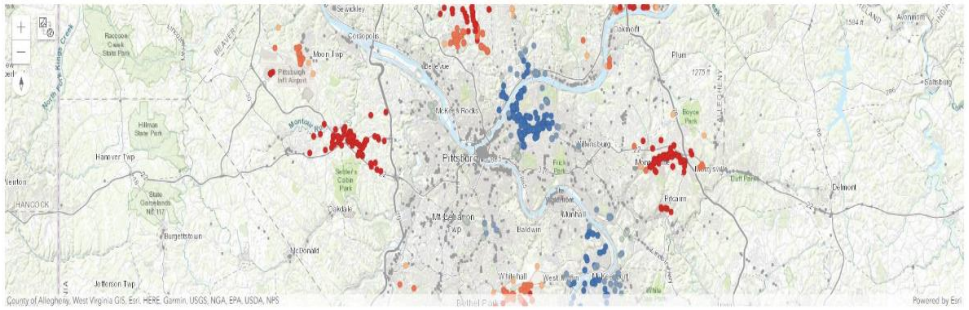
```
df.head()
```

	WEATHER STATION	LOCATION	RAINFALL
0	TAMBARAM	TAMBARAM, TAMIL NADU	49
1	CHEMBARABAKKAM	CHEMBARABAKKAM, TAMIL NADU	47
2	MARAKKANAM	MARAKKANAM, TAMIL NADU	42
3	CHENGALPATTU	CHENGALPATTU, TAMIL NADU	39
4	PONNERI	PONNERI, TAMIL NADU	39

Tabular data is hard to visualize, so let's bring in a map from our GIS to visualize the data:

In [67]:
```
# Create a map of Pittsburgh to show hot spot outputs
hot_spots_map = gis.map("Pittsburgh")
hot_spots_map.add_layer(restaurant_hot_spots_item)
hot_spots_map.zoom = 10
hot_spots_map
```

Out[67]:



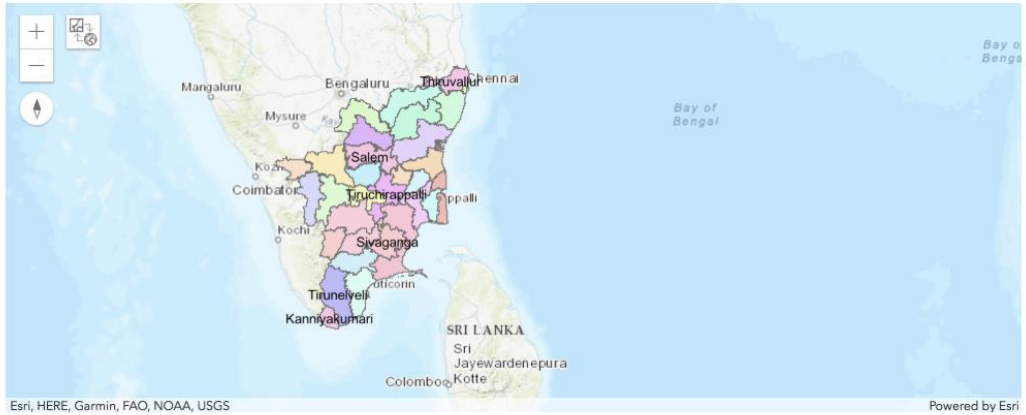
jupyter 2017 Southern California Wildfires analysis Last Checkpoint: 12/22/2017 (unsaved changes) | Logout

File Edit View Insert Cell Kernel Widgets Help | Trusted | Python [default]

Code | Snippets | Dashboard View:

In [81]:
```
map = gis.map("Chennai")
map
```

Out[81]:



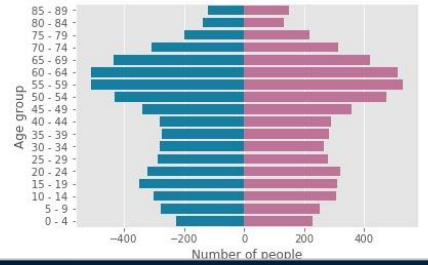
We can search for content in our GIS and add layers to our map that can be used for visualization or analysis:

Age Pyramid of affected population

In [23]:
```
print('Number of affected people: ' + str(popdf['female'].sum() - popdf['male'].sum()))
```

```
Number of affected people: 11226
```

In [24]:
```
sns.barplot(x="female", y="agelabel", color="#CC6699", label="Female", data=popdf, edgecolor='none')
sns.barplot(x="male",   y="agelabel", color="#008AB8", label="Male",   data=popdf,  edgecolor='none')
plt.ylabel('Age group')
plt.xlabel('Number of people');
```



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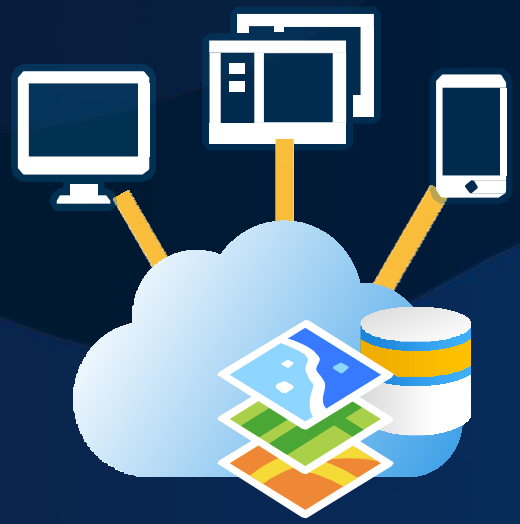
Demo

Palm Detection using Deep Learning In Jupyter Notebook/Lab



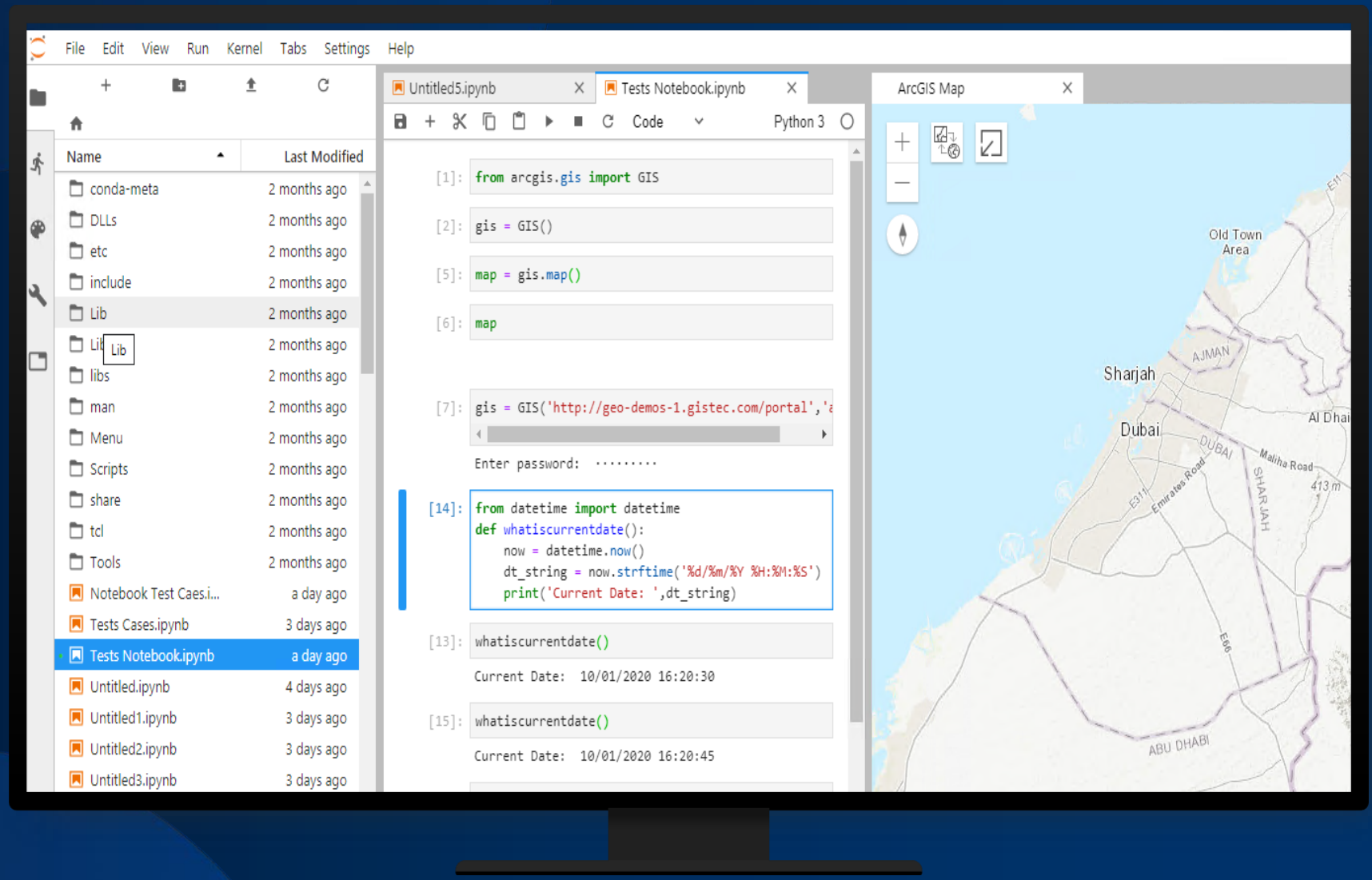


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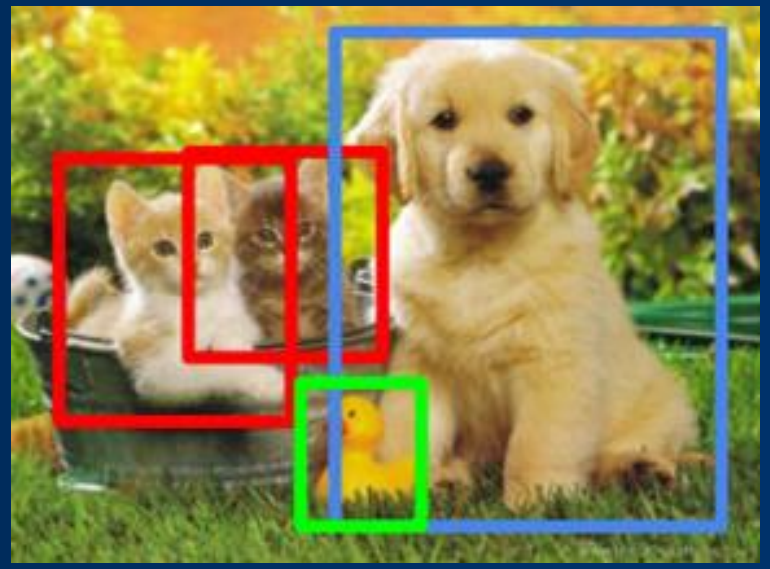
Image Classification vs Object Detection

Image Classification



Object Detection

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Deep Learning

Palm Detection Input

Tanga / Kolovai

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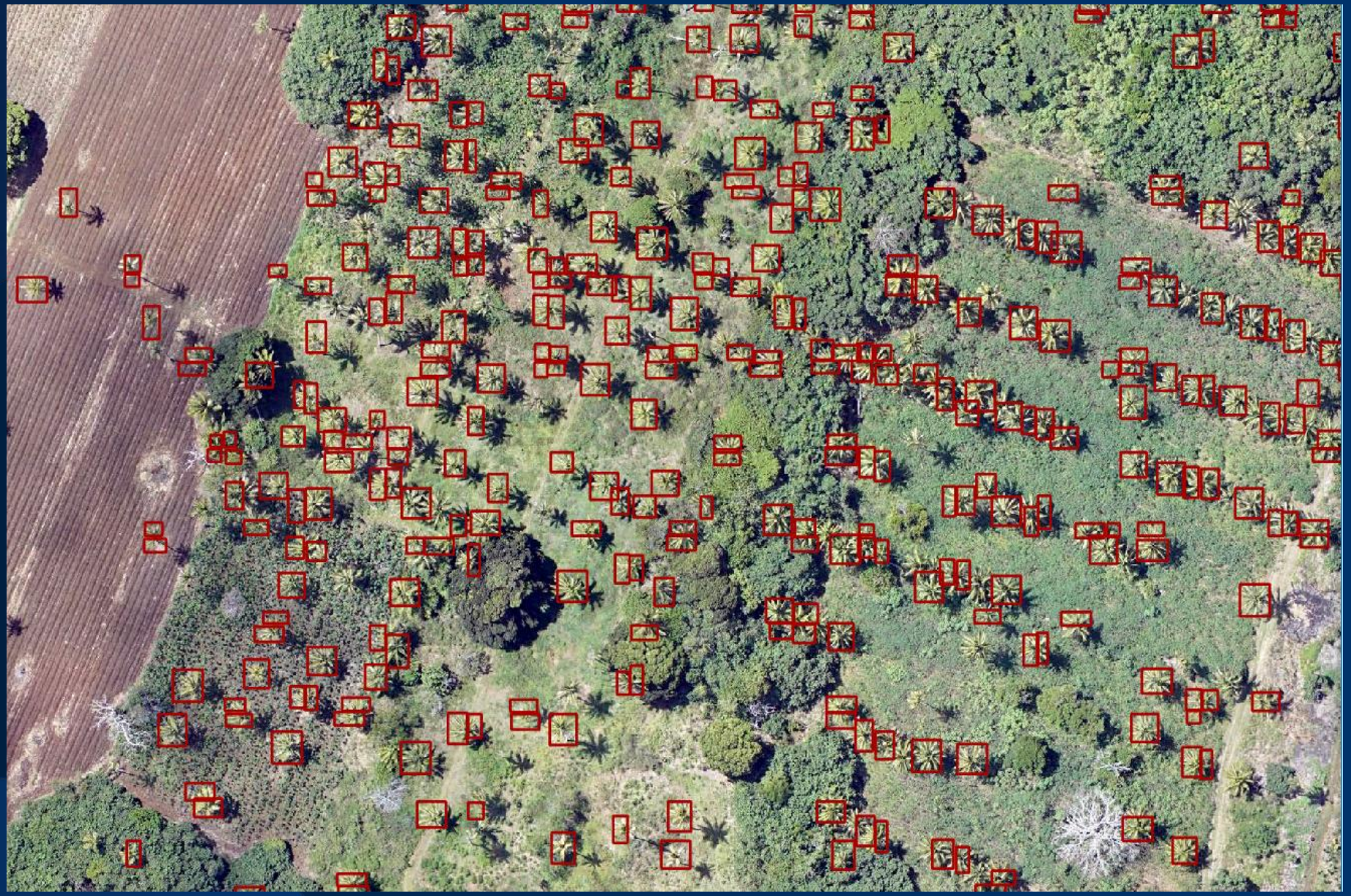
Deep Learning

Palm Detection Output



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Deep Learning

Palm Detection

Feature To Point

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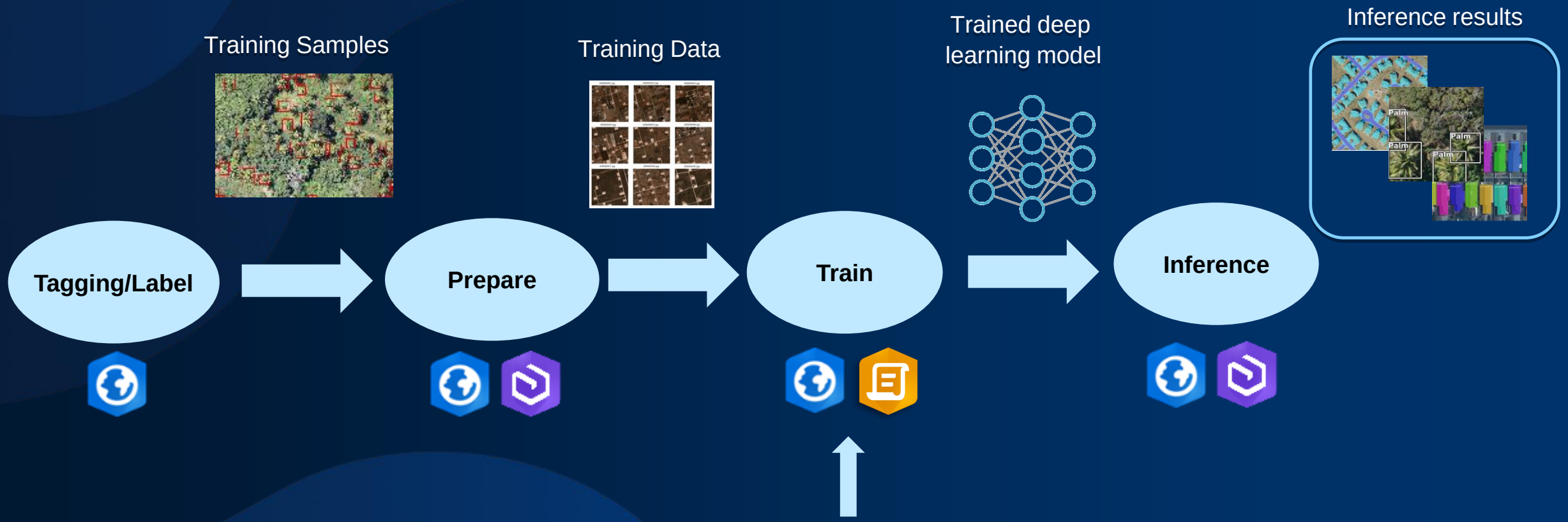
Deep Learning / Object Detection Workflow in ArcGIS



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ArcGIS Notebooks

Introduction

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What is ArcGIS Notebooks?

A new capability that lets you create hosted Python notebooks using a Juypter scripting environment that has been built into ArcGIS.

In 2020, ArcGIS Notebooks will be available in…

ArcGIS Enterprise

ArcGIS Pro

ArcGIS Online

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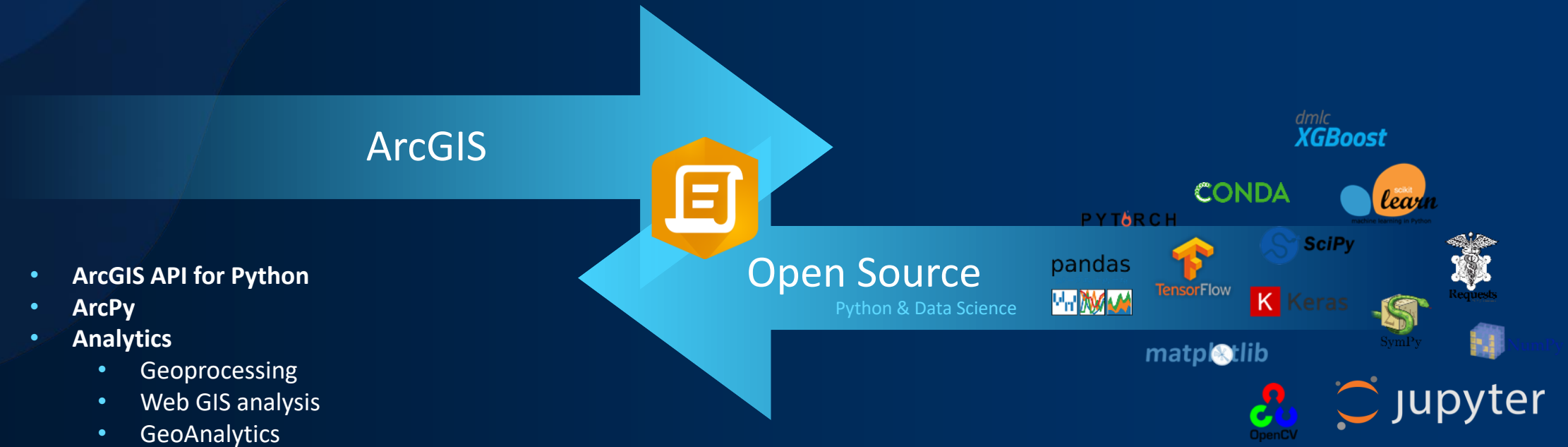
ArcGIS Notebooks sits at the intersection of ArcGIS and open data science



- **ArcGIS API for Python**
- **ArcPy**
- **Analytics**
  - Geoprocessing
  - Web GIS analysis
  - GeoAnalytics
  - Raster Analytics

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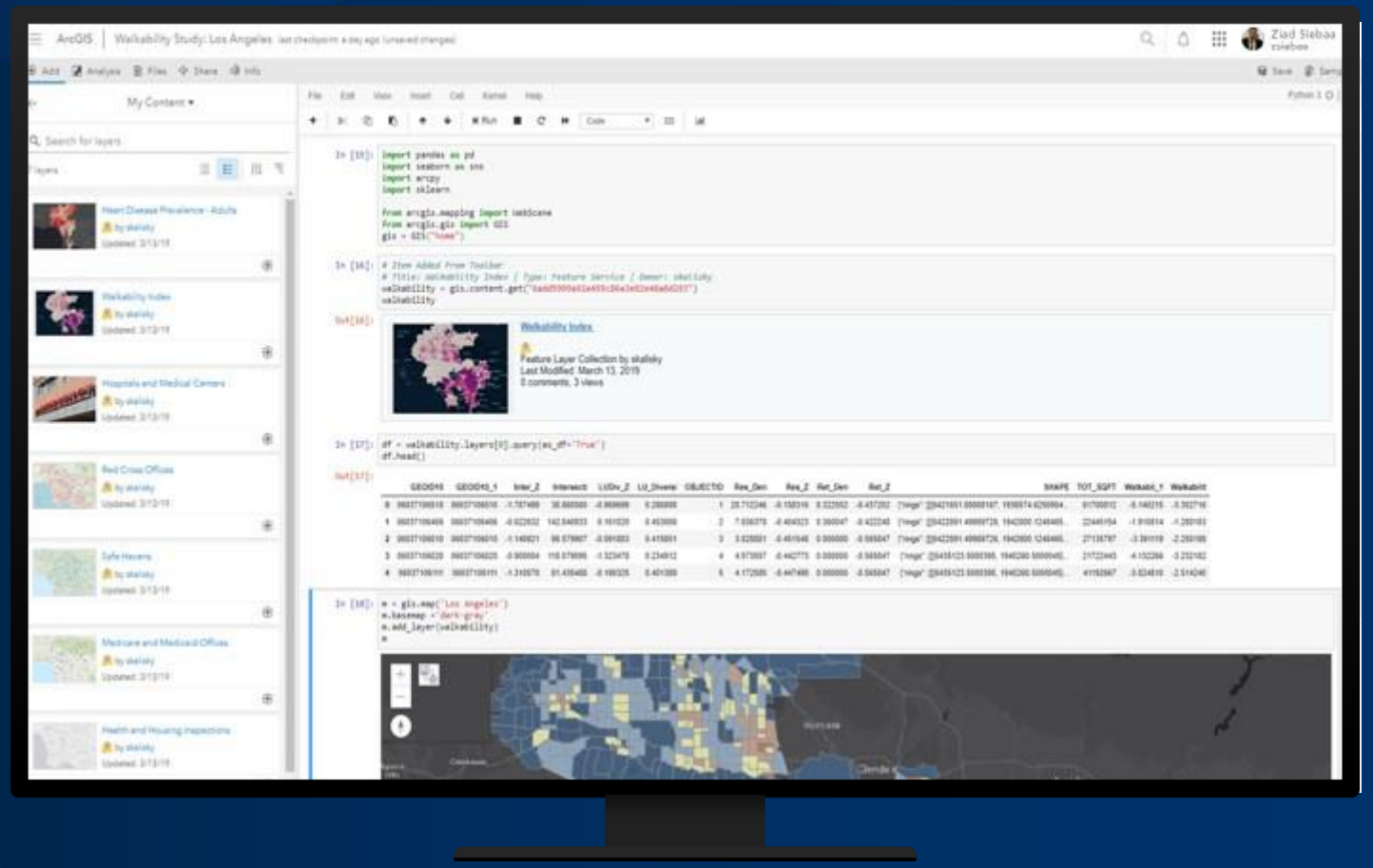
Demo

Quick tour of ArcGIS Notebooks



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How is ArcGIS Notebooks different than “traditional” Jupyter?

- Built within ArcGIS rather than sitting beside it
- Leverages an integrated UI
  - Automatically insert Python snippets
  - Quickly access a gallery of samples
- Notebooks as items
- Use ArcPy without ArcGIS Pro
- Centrally manage libraries and packages

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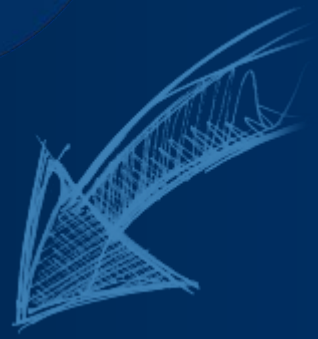
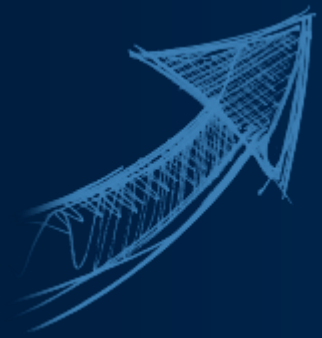
Python != Notebooks



Computational environment.
Could be used with other programming languages.



Programming language.
There are many ways to write and execute Python code.

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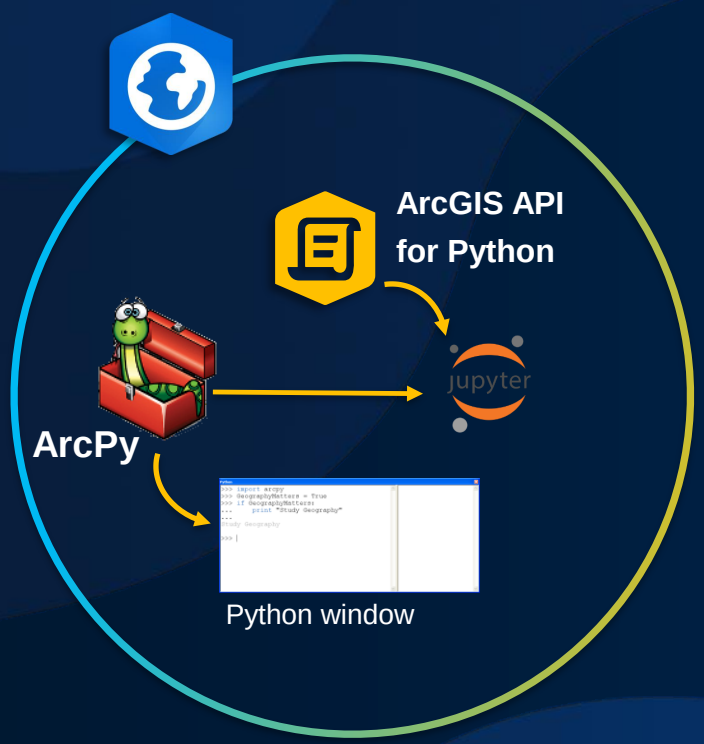
Why do we talk about Python and notebooks together?

ArcGIS Pro



ArcGIS API for Python

User managed Jupyter

ArcGIS Notebooks

Integrated experience within the Web GIS

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What does ArcGIS Notebooks provide?

- Ready-to-use scripting libraries
  - ArcGIS API for Python
  - Mathematical, statistical, and machine learning libraries
  - ArcPy
  - Python libraries and packages are synchronized across the organization
- A gallery of curated notebook samples
  - Samples generated by Esri data scientists, engineers, and analytical teams
  - Notebook samples are end-to-end workflows that include all necessary datasets
  - Administrative notebook samples included
- One-click access to a new notebook
- Seamless integration with the Web GIS interface
  - Access to data and analysis tools in your Web GIS, collaborate and share
- Secure identity-based access
  - Read-only previews of notebooks

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How do notebooks help people solve problems?

- **They tell a story**
  - **Promote transparency and reproducibility**
  - **Help turn analysis into action**
- **They allow you to iterate and get feedback quickly because they are interactive**
- **Help people create more effective models by using spatial data and analysis tools**
- **Integration with ArcGIS, to promote collaboration and sharing**

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Essential knowledge

Images and containers

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Terminology - Docker

- Docker is a tool designed to make it easier to create, deploy, and run applications by using containers.
- Container – A virtualized workspace that packages up all the code and dependencies a user needs to run the application.
  - Not a VM
    - Virtual machines virtualize hardware
    - Containers virtualize the OS
- Image – Instructions for Docker on how to setup the container.
  - ArcGIS Notebook Server includes two images:
    - ArcGIS Notebook Server Standard
    - ArcGIS Notebook Server Advanced
  - Customers have the option of creating their own custom images to use with ArcGIS Notebook Server
  - Within the product we refer to the Docker images as notebook runtimes
- Within ArcGIS Notebook Server, each user gets one container per notebook runtime they have access to.

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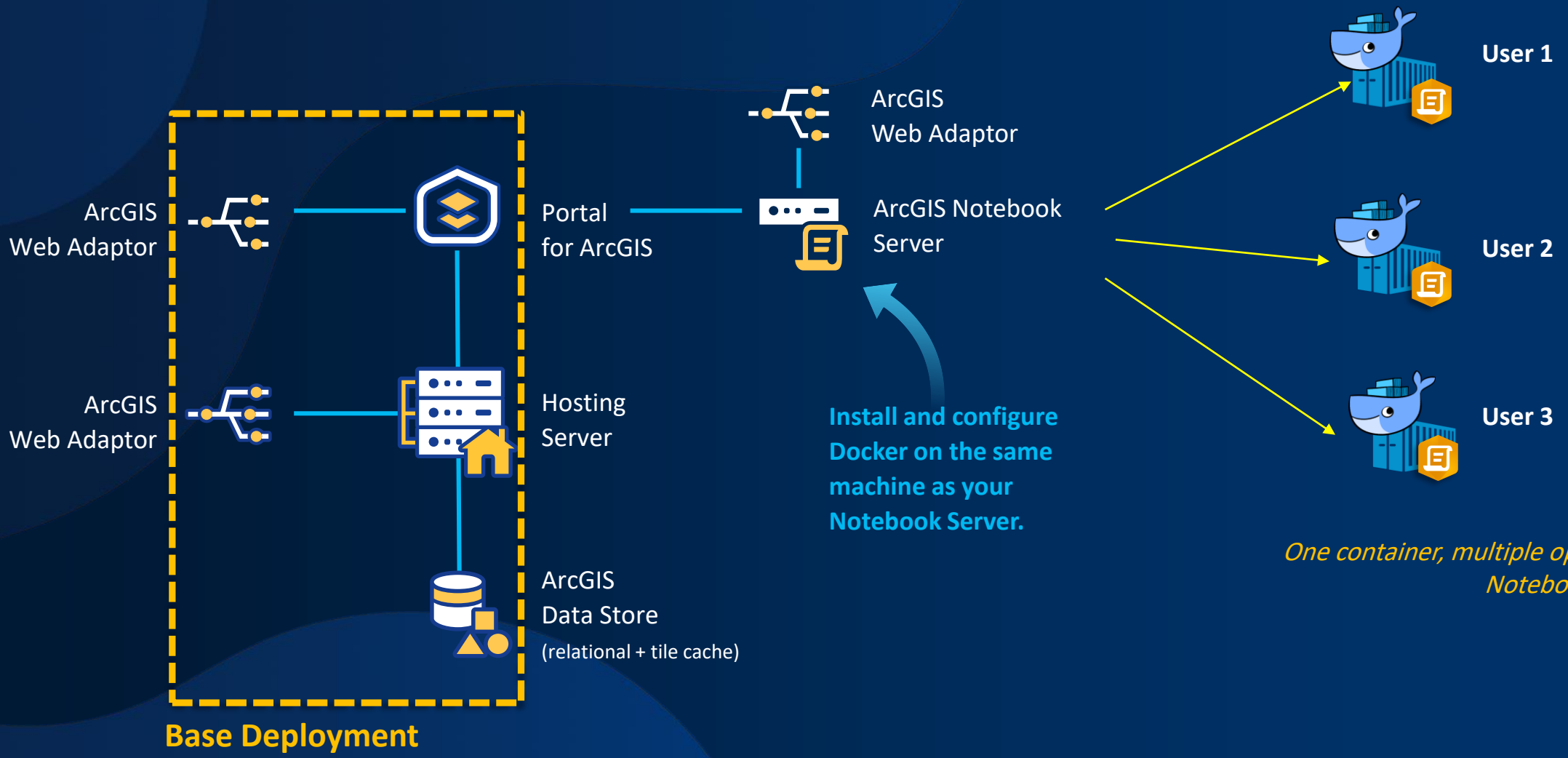
Conceptual Architecture



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Why do we use Docker?

- Security
- Code isolation

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Who can create and run notebooks?

- Administrators
- Non-administrators will require a custom role
- These are the only people who will see the Notebook option in the top ribbon of the portal

- Minimum user type is a Creator

- If a notebook is shared with someone who does not have privileges to create and run notebooks they will only be able to:
  - View the notebook’s item details page
  - Preview the notebook
  - Download the notebook

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Sample notebooks

Deep Learning: Detect swimming pools, part 1

Notebook by esri_notebook

Export training data for object detection.

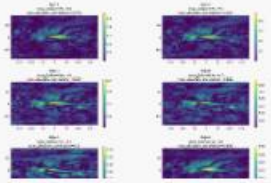
Created: Jan 28, 2019 Updated: Jan 28, 2019 View Count: 0

Deep Learning: Downscale climate models

Notebook by esri_notebook

Harness ArcGIS platform's internal machine learning libraries and strong extensibility to external machine learning libraries to downscale climate models

Created: Jan 28, 2019 Updated: Jan 28, 2019 View Count: 0

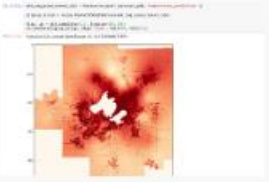


Deep Learning: Predict El Niño-southern oscillation

Notebook by esri_notebook

This example uses correlation analysis and time series analysis to predict El Niño-Southern Oscillation (ENSO) based on climate variables and indices.

Created: Jan 28, 2019 Updated: Jan 28, 2019 View Count: 0



EBK Regression: Identify urban heat islands

Notebook by esri_notebook

Interpolate temperature measurements to identify city areas with high temperatures and high desnity of residents.

Created: Jan 28, 2019 Updated: Jan 28, 2019 View Count: 0

Exploratory Statistics: Hurricane analysis, part 2/3

Notebook by esri_notebook

Perform exploratory data analysis on hurricane tracks.

Created: Jan 28, 2019 Updated: Jan 28, 2019 View Count: 0

Forest-based Classification: Predict asthma rates

Notebook by esri_notebook

Determine what census block groups in Connecticut have the highest children's hospitalization rates for asthma related

Samples

- Types of samples:
  - Data science and analysis
  - Content management
  - Administration
- Some notebooks are ready-to-run, others require additional configuration
- Notebook samples that use ArcPy require Advanced privileges
- Some samples require utility services
- Data is included and available for all notebooks

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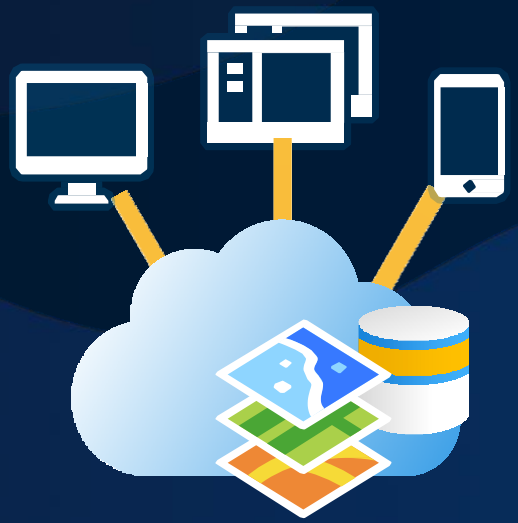
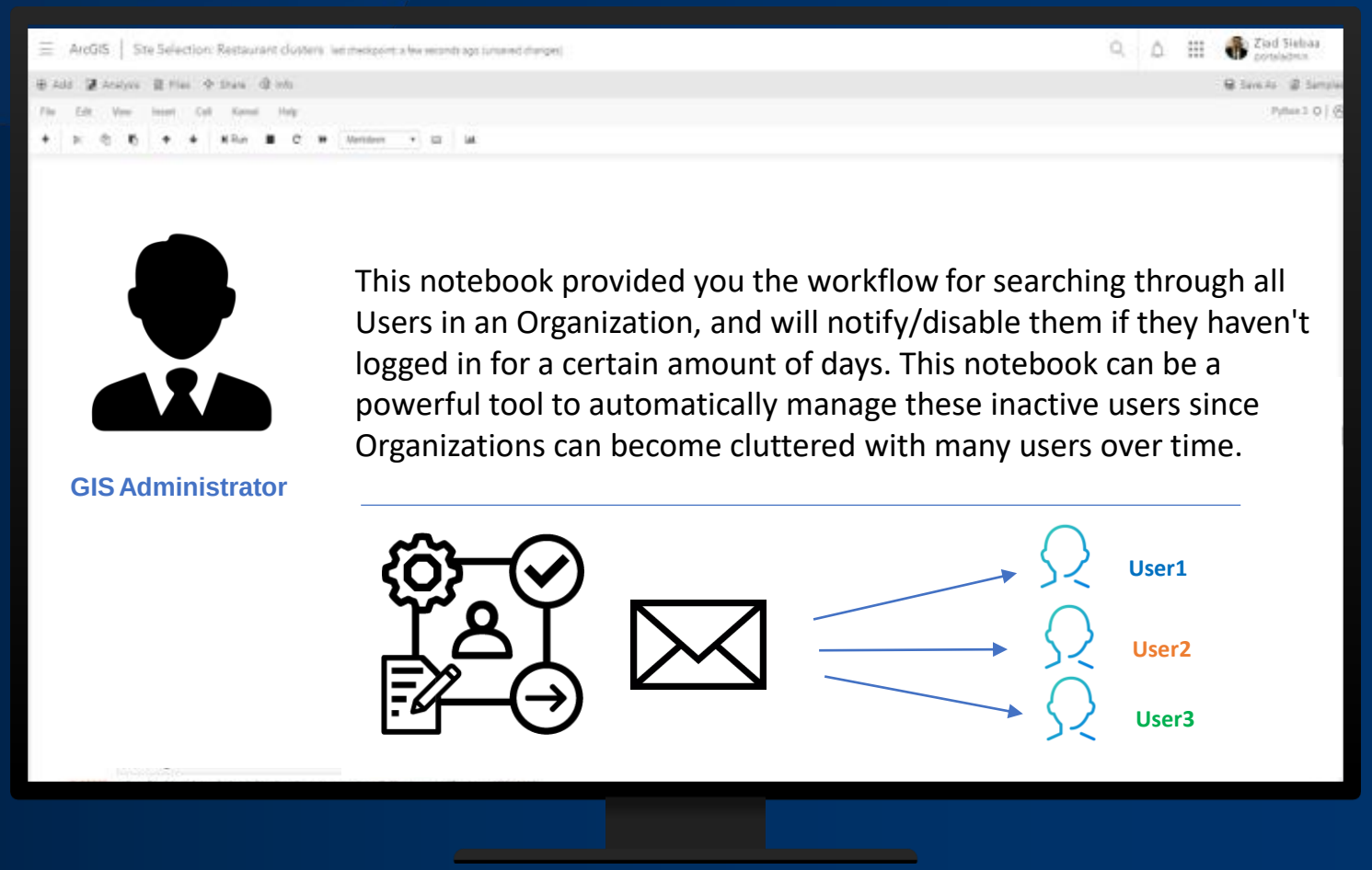
Sample #1

Administration: Manage inactive users





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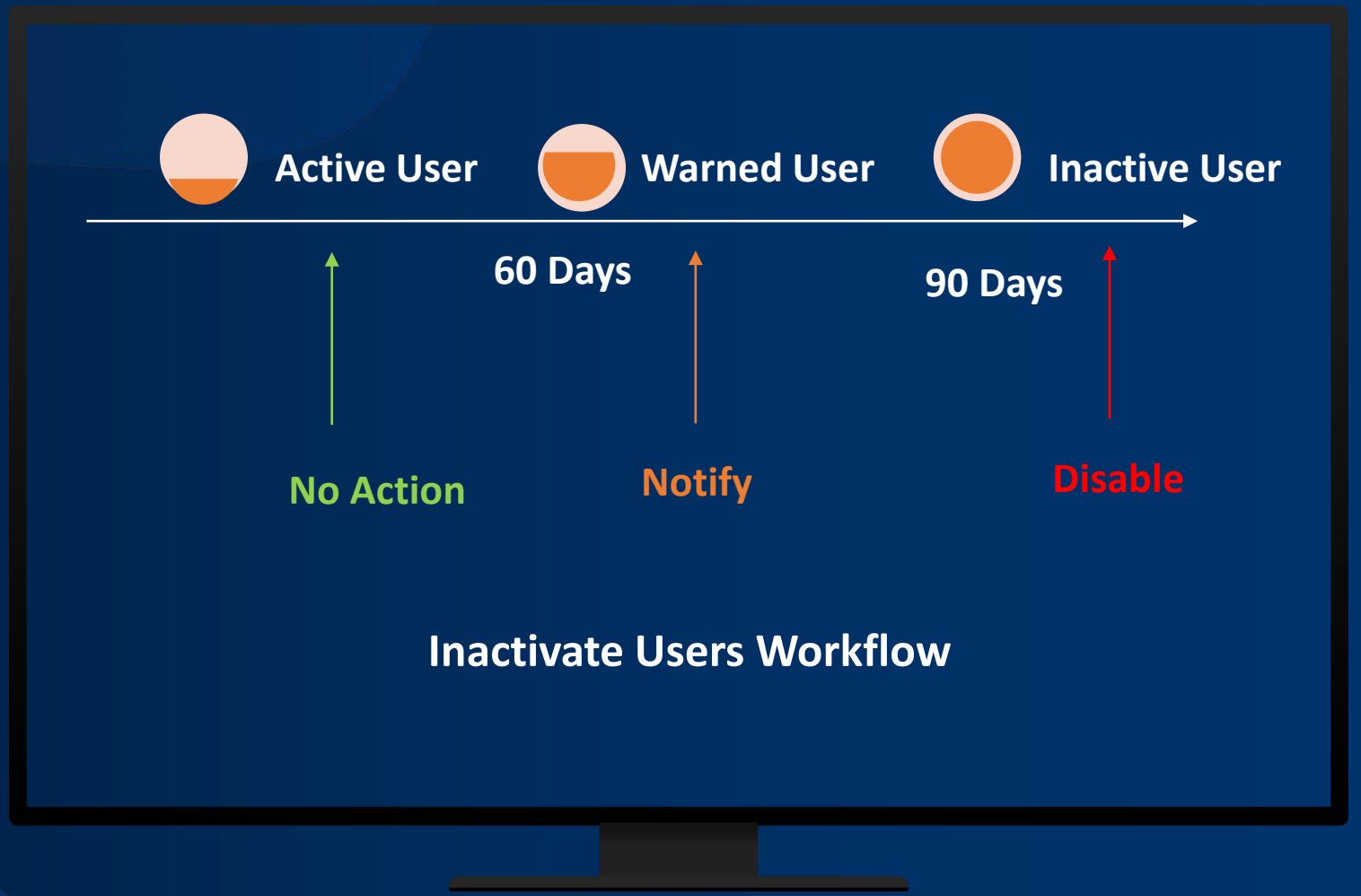
Sample #1

Administration: Manage inactive users



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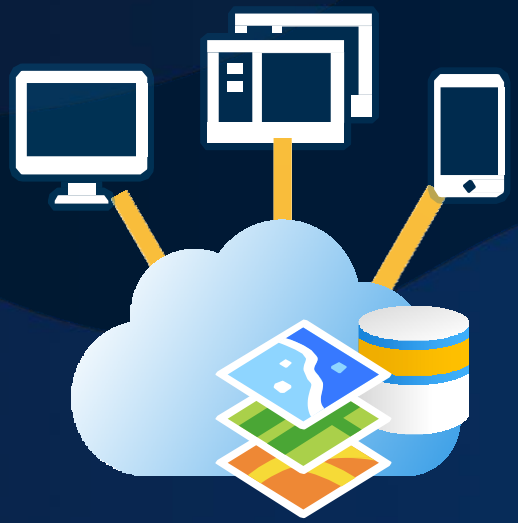
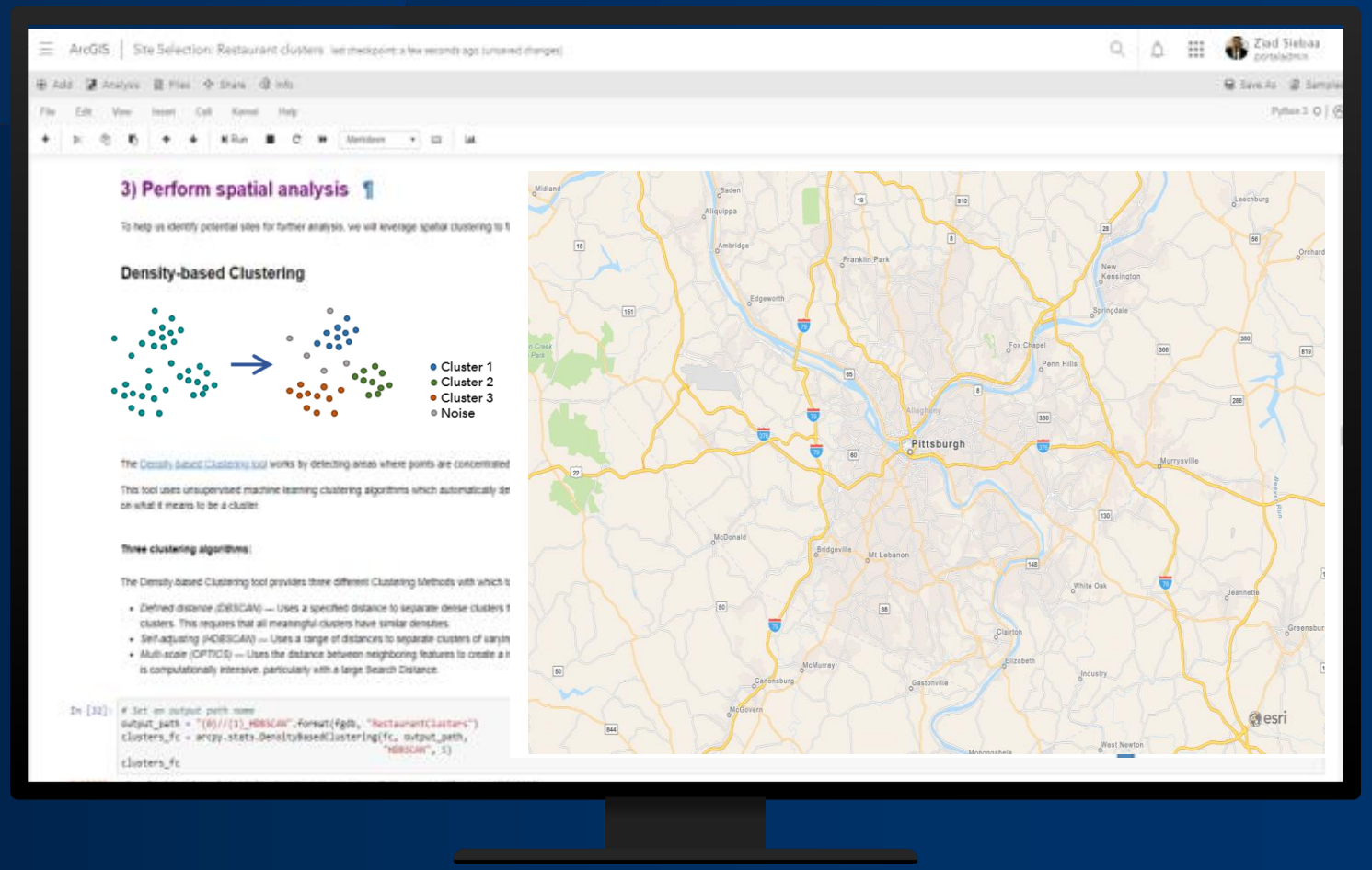
Sample #2

Data Science: Site Selection / Restaurant clusters





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Deployment, Setup and Licensing

Images and containers

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ArcGIS Notebooks

- In ArcGIS Enterprise at 10.7 we talk about ArcGIS Notebook Server
  - Server licensing role
  - 2 levels: Standard and Advanced

- In ArcGIS Online 2020 we talk about ArcGIS Notebooks
  - There is no server or infrastructure for the customer to setup
  - More details to be announced later this year

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What's the difference between Standard and Advanced → ArcPy!

ArcGIS API for Python + 3rd party Python libraries (over 175 Library)

Standard + ArcPy libraries

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Note: Don’t let the names fool you

- The terms Standard and Advanced only denote functionality differences relative to the specific server role.

- ArcGIS Enterprise Standard or Advanced is a prerequisite, however:
  - An ArcGIS Enterprise Standard customer could choose to purchase ArcGIS Notebook Server Advanced
  - An ArcGIS Enterprise Advanced customer could choose to only use ArcGIS Notebook Server Standard

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System Requirements

	Windows	Linux

Prerequisites	• HyperV
	• Docker Desktop
	  - Docker must use Linux containers
		• Docker
		  - The specific version of Docker will depend on the OS selected

Hardware Requirements	• 8 GB RAM • 50 GB disk space	• 8 GB RAM • 50 GB on /var directory
Operating Systems	• Window Server 2016 (Standard or higher) • Windows Server 2019	• Red Hat Enterprise Linux Server 7 • Ubuntu LTS Server 16.04 or 18.04
Browsers	• Chrome • Firefox • Edge	• Chrome • Firefox • Edge

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Resources

- Website : https://developers.arcgis.com/python/
- GitHub repo : https://github.com/Esri/arcgis-python-api
- Try it Live! : https://notebooks.esri.com
- API Reference : https://esri.github.io/arcgis-python-api/apidoc/html/
- Community : https://community.esri.com/groups/arcgis-python-api/
- Documentation : https://developers.arcgis.com/python/api-reference/index.html
- Object Detection : https://learn.arcgis.com/en/projects/use-deep-learning-to-assess-palm-tree-health/

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Thank you!

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