Spatial Analytics Working Group
Session III
May 19, 2025

Stephen P. Gaughan
https://dartgo.org/steve
Dartmouth Libraries - Research Data Services
ResearchDataHelp@groups.dartmouth.edu
https://researchguides.dartmouth.edu/data_management

DARTMOUTH

About the Spatial Analytics Working Group

- A new concept from **Research Data Services @ Dartmouth Libraries**
- Building community around spatial analytics & geospatial data
    - Spatial analytics & geospatial data visualization
    - Geographic information systems software
    - Pipelines & workflows, using tools like R and Python with spatial libraries
    - Spatial data management & research data management
    - Geography, Earth Sciences, Anthropology, Economics, Government, Public Health & Epidemiology, social sciences data
- **Meet** the people on campus with similar interests
- **Engage** in community discussions to learn from other researchers on campus
- **Attend** our meetings and workshop to **learn** practical tools and tips
- **Contribute** ideas, insight, tools, methods, code

About Research Data Services

Research Data Management

Data Management Plans for sponsored projects

Finding and using third party data

Collection and cleaning of data

Organization and documentation

Publishing and data repositories

Data Science, Data Analysis, Data Visualization

Textual, numerical, spatial data

Assistance with building reproducible workflows

Scripting in R and Python

Computational Scholarship

Computational project planning

Collections as data

Storytelling with data and visualizations

Text and data mining

Digital Humanities support

Computational Pedagogy

Geographic Information Systems (GIS) at Dartmouth

- Geography Department, Earth Sciences
  - Geog 50 Geographical Information Systems
  - Geog 54 Geovisualization
  - Geog 59/Ears 77 Environmental Applications of GIS
  - Geography https://geography.dartmouth.edu/
  - Earth Sci: https://earthsciences.dartmouth.edu/
- Evans Map Room (2nd Floor Berry) & Dartmouth College Library Lib Guides
  - https://researchguides.dartmouth.edu/gis
  - https://researchguides.dartmouth.edu/gisdata
  - https://researchguides.dartmouth.edu/webmapping
- ArcGIS Online (SSO sign on) https://dartmouth.maps.arcgis.com

At the last meetings…

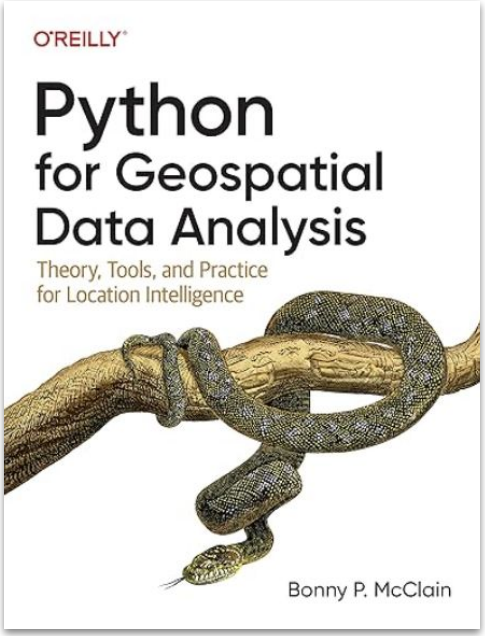
- Overview of Spatial Analytics
- Software
  - Some common sources of data and GIS Tasks
  - Some quick tools to get up and running with GIS
  - GIS software and tools
- Hardware
- Data
- People
  - Dartmouth Library
  - Department courses, Geography, Earth Sciences
  - Research Computing @ ITC High Performance Computing
- Google Colab, CSV's and shapefiles
- Workflows, resources & links
- Slides & code were sent after the meetings

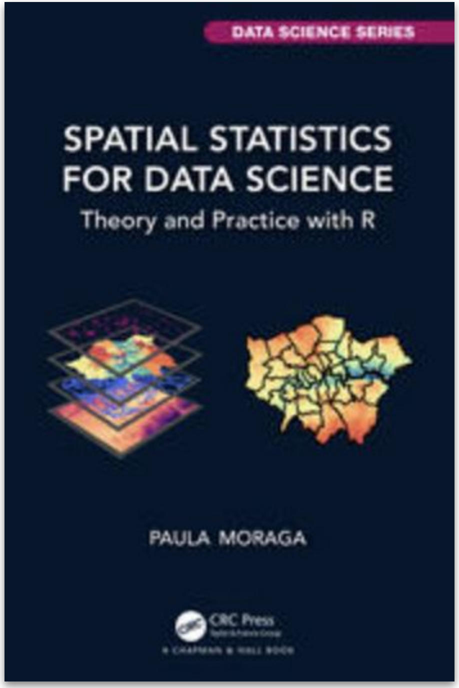
A roadmap for today's meeting & workshop

- Overview
- Web Mapping with Python
- Leaflet.js
- Emerging AI concepts for GIS & spatial data
- Hardware & Data
- People
  - Dartmouth Library
  - Department courses, Geography, Earth Sciences
  - Research Computing @ ITC High Performance Computing
- Resources & links
- Slides will be sent after the workshop

Motivation

- Spatial analytics toolbox approach
- Spatial Data
- Geospatial data science
- Software & tools
- ArcGIS (Online, Pro)
- QGIS
- Python & R


O'REILLY
Python for Geospatial Data Analysis
Theory, Tools, and Practice for Location Intelligence
Bonny P. McClain


DATA SCIENCE SERIES
SPATIAL STATISTICS FOR DATA SCIENCE
Theory and Practice with R
PAULA MORAGA
CRC Press

Spatial Statistics for Data Science: Theory and Practice with R, Paula Moraga, 2024
Python for Geospatial Data Analysis: Theory, Tools, and Practice for Location Intelligence, Bonny P. McClain, 2022

Common spatial analytics areas and tasks

- **Collecting, creating spatial data**, mapping and **spatial analysis**, transform data, new insights and results, **data visualizations**
- **Geocoding** - locating a list of street addresses on a map
- Satellite imagery, aerial or drone imagery analysis of the terrain, vegetation, buildings and infrastructure, extracting features
- Population, demographics research
- **Georeferencing** historical maps, imagery
- Movements of populations over time, movement of political boundaries over time (e.g. ancient civilizations, migration, etc)
- Mapping distribution of features (natural resources, tax dollars, plants, animals, emergency aid for fires, earthquakes, hurricanes, etc)
- Regional planning - campuses, towns, counties, states

Quick ways to start to build a pipeline

- Pipeline construction
  - What is the problem we are trying to solve, or what is the process we need to build, manage and deliver or maintain?
  - What data sources are available to answer the question(s), what data sources to we need to find, collect or create? (Survey tools, fieldwork, etc)
  - Are there data cleaning steps?
  - What are the analysis steps?
  - What are the final results? New insights, new visualizations, new statistical values

esri ArcGIS

3.26.3
3.22.11 LTR

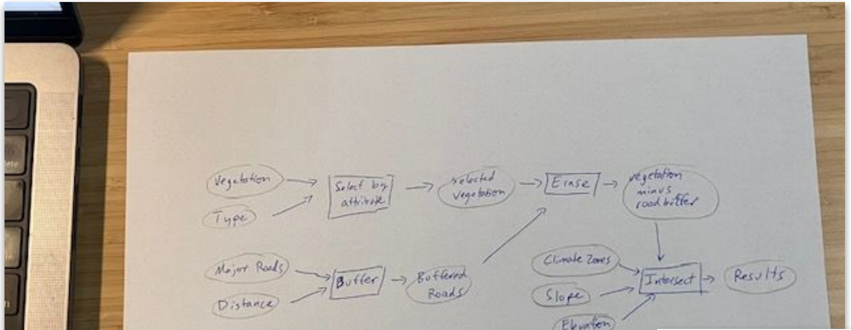
R Studio

python™

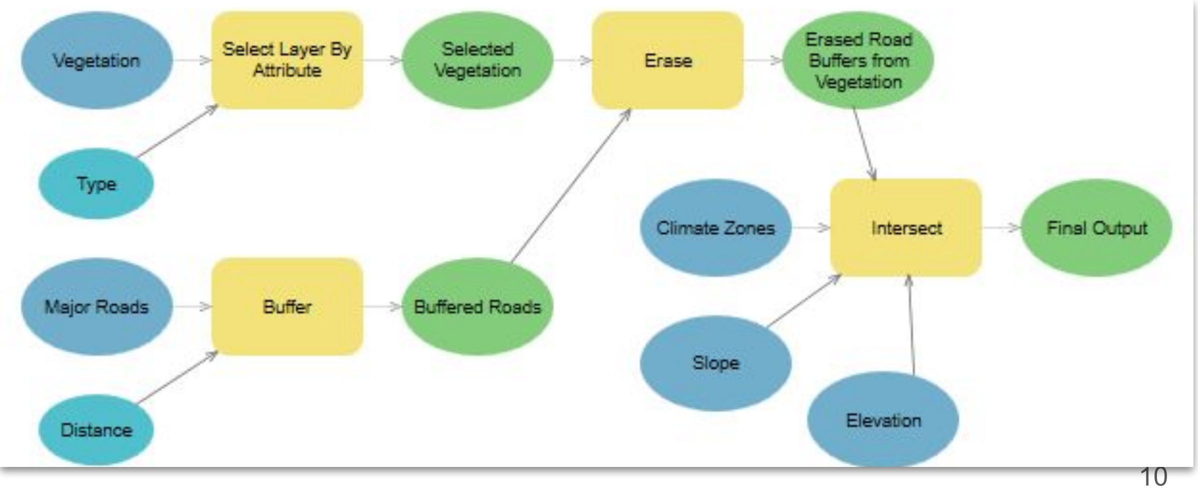
Leaflet

Analysis pipelines

- Pipeline construction
  - Pen & Paper – START HERE!
  - ArcGIS Pro / ESRI's Model Builder
  - Build graphically
  - Can be exported to Python code



In this example, blue ovals are spatial data and constants. Yellow rectangles are tools, and green ovals are outputs Outputs along the route do not necessarily need to be saved



ArcGIS Online Modelbuilder is in beta testing

Image source: https://pro.arcgis.com/en/pro-app/latest/help/analysis/geoprocessing/modelbuilder/what-is-modelbuilder-.htm

Quick ways to start to build a pipeline

- Pipeline construction
  - ArcGIS / ESRI's Model Builder
  - Build graphically
  - Can be exported to Python code

The model runs the following tools in sequence:

Select Layer By Attribute—Select the correct vegetation type from a Vegetation map layer.
Buffer—Create areas within a distance of 1,500 feet around major roads.
Erase—Erase the buffer areas from the selected vegetation areas.
Intersect—Overlay the output of the Erase tool with other map layers, including slope, elevation, and climate. This identifies the areas that meet all criteria.

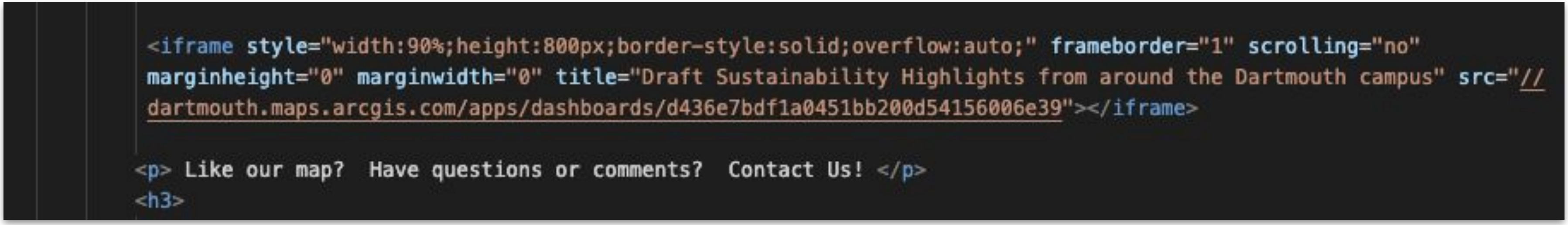
source: https://pro.arcgis.com/en/pro-app/latest/help/analysis/geoprocessing/modelbuilder/what-is-modelbuilder-.htm

Web mapping

- ArcGIS Online
  - ArcGIS Online on its own (web map, web application)
  - Imbedded in HTML/Javascript
    - For example, https://rcweb.dartmouth.edu/~f002d69/geospatial/geospatial/dev/index.html
- Google Colab with Python & Folium & Leaflet base maps
- HTML & Javascript with Leaflet.js and RCweb
  - https://rcweb.dartmouth.edu/~f002d69/geospatial/geospatial/dev/index-dev.html

Web maps - ArcGIS Online (solo) and imbedded

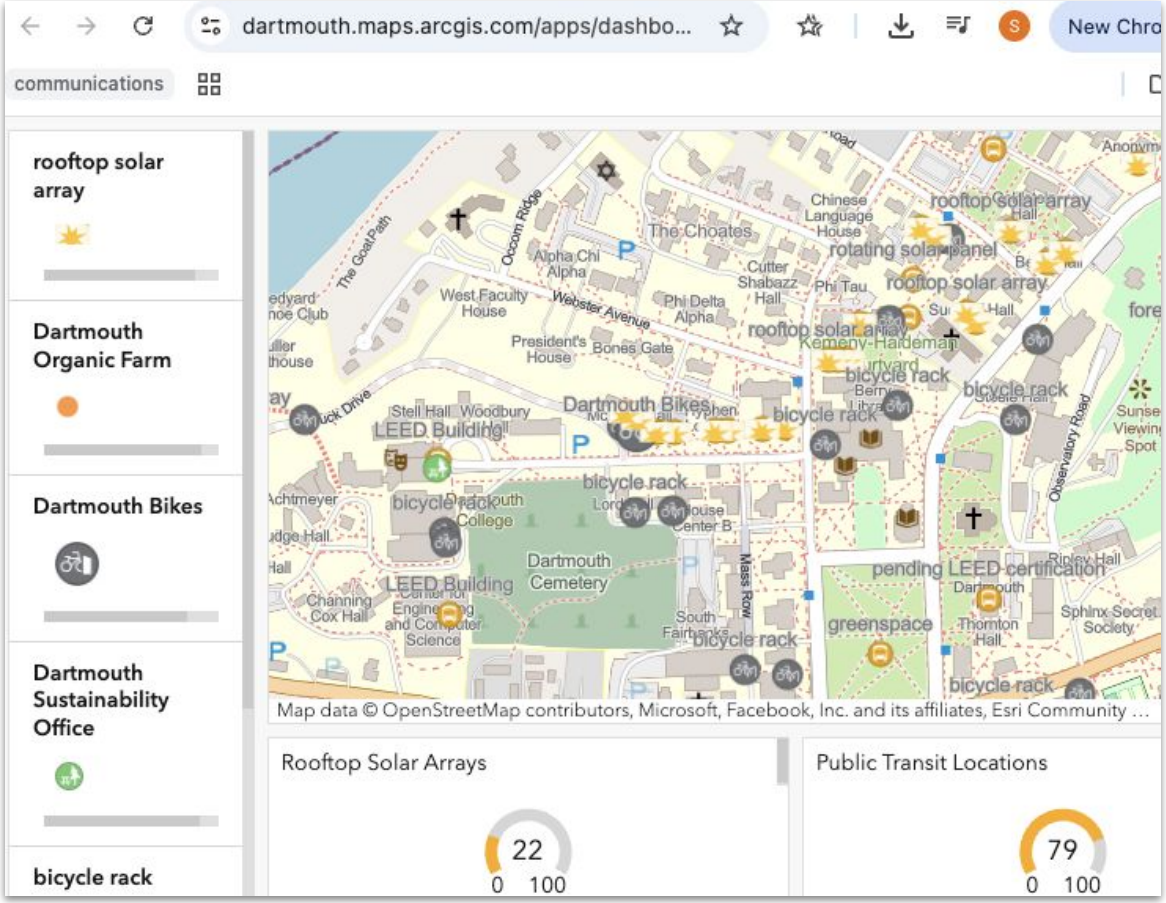
- ArcGIS Online
  - Solo
    - https://dartmouth.maps.arcgis.com/apps/dashboards/d436e7bdf1a0451bb200d54156006e39
  - An iframe (inline frame) is an HTML element that can embed another HTML document (using it's URL) and display within the current page
  - Imbedded Iframe <iframe></iframe>
    - https://rcweb.dartmouth.edu/~f002d69/geospatial/geospatial/dev/index.html



```
  <iframe style="width:90%;height:800px;border-style:solid;overflow:auto;" frameborder="1" scrolling="no"
  marginheight="0" marginwidth="0" title="Draft Sustainability Highlights from around the Dartmouth campus" src="//
  dartmouth.maps.arcgis.com/apps/dashboards/d436e7bdf1a0451bb200d54156006e39"></iframe>

<p> Like our map?  Have questions or comments?  Contact Us! </p>
<h3>
```

ArcGIS Online

- Option 1, use ArcGIS Online's 'web mapping application'



rooftop solar array ✹

Dartmouth Organic Farm ●

Dartmouth Bikes

Dartmouth Sustainability Office

bicycle rack

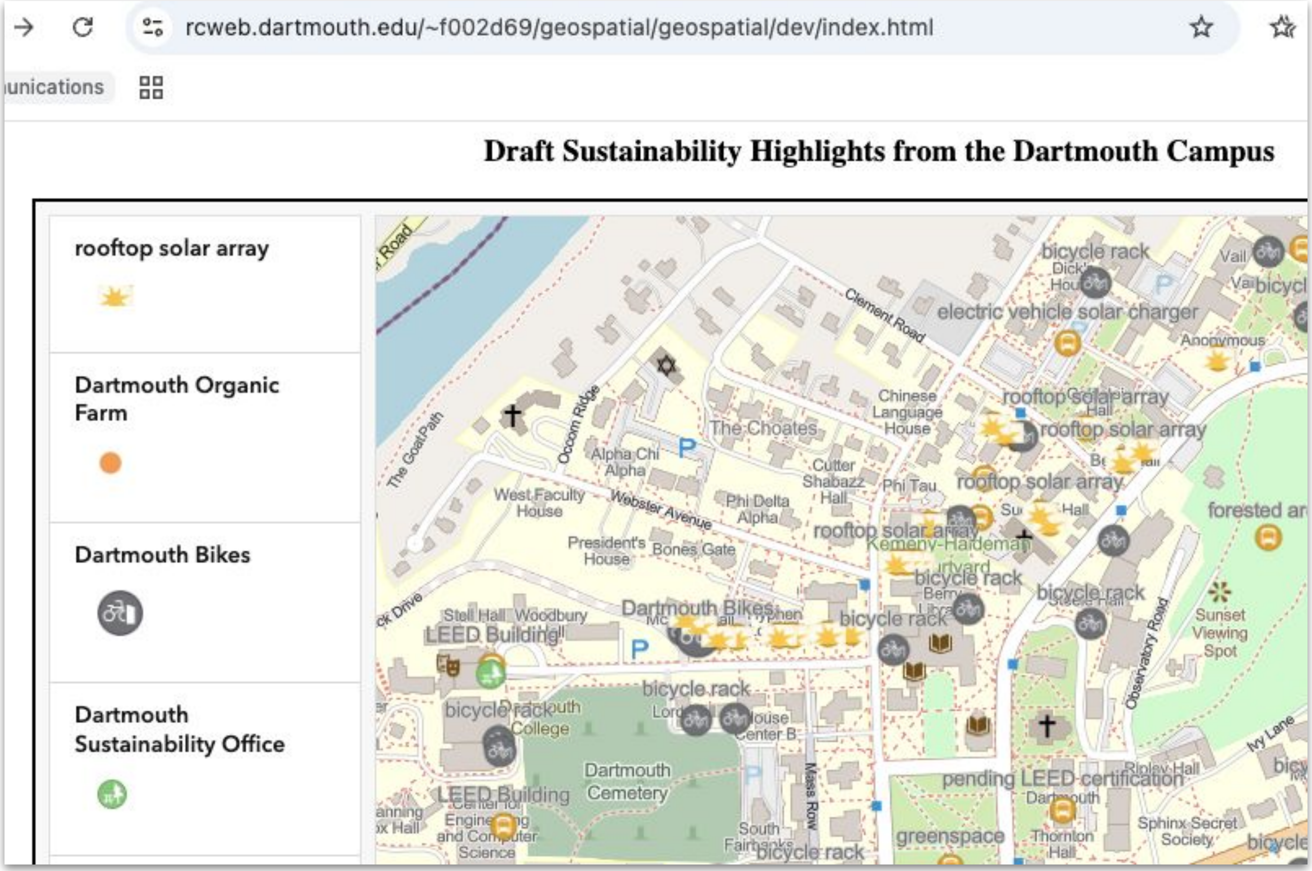
Map data © OpenStreetMap contributors, Microsoft, Facebook, Inc. and its affiliates, Esri Community ...

Rooftop Solar Arrays: 22 (0 to 100)

Public Transit Locations: 79 (0 to 100)

HTML & Javascript with an imbedded iframe

- Option 2, build in ArcGIS Online, then embed the web mapping application using an iframe (<iframe>url to map </iframe>)



rcweb.dartmouth.edu/~f002d69/geospatial/geospatial/dev/index.html

Draft Sustainability Highlights from the Dartmouth Campus

rooftop solar array

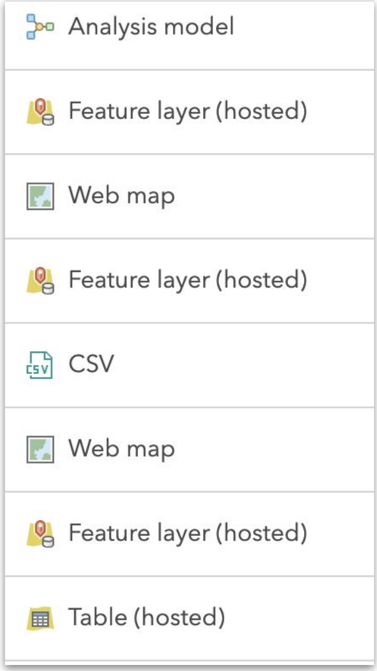
Dartmouth Organic Farm

Dartmouth Bikes

Dartmouth Sustainability Office

Content types

- ArcGIS Online web maps, web mapping application



Analysis model

Feature layer (hosted)

Web map

Feature layer (hosted)

CSV

Web map

Feature layer (hosted)

Table (hosted)

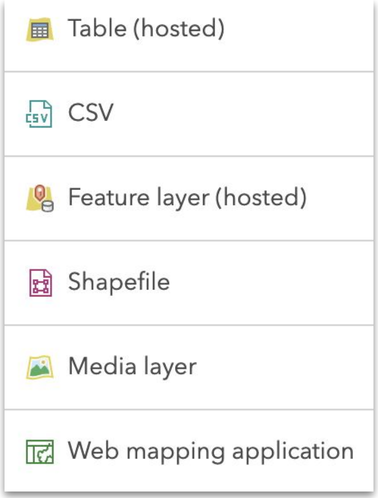


Table (hosted)

CSV

Feature layer (hosted)

Shapefile

Media layer

Web mapping application

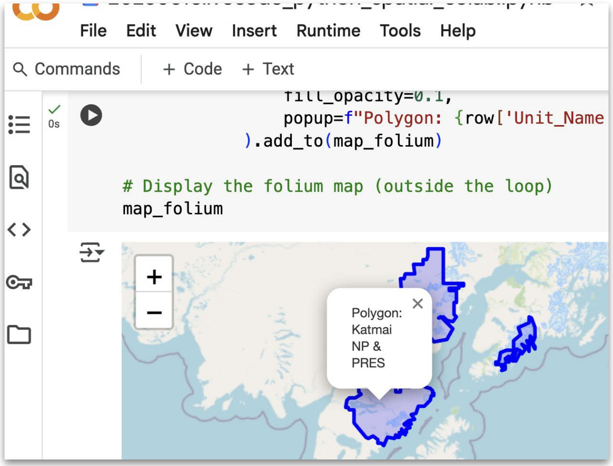
Sample data & Python notebook

Sample data & Google Colab Python code/notebook

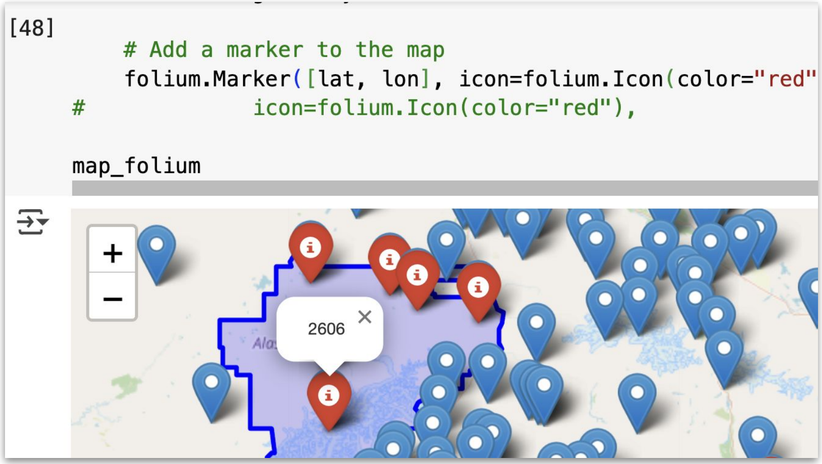
- https://dartgo.org/workshop-share
- https://dartgo.org/rds-workshop

Google Colab with Folium (Leaflet) basemaps and functions

- Colab Python notebooks
  - Text
  - Code
  - Visualizations - plots, bar graphs, line graphs, etc
  - Maps
  - Markdown text

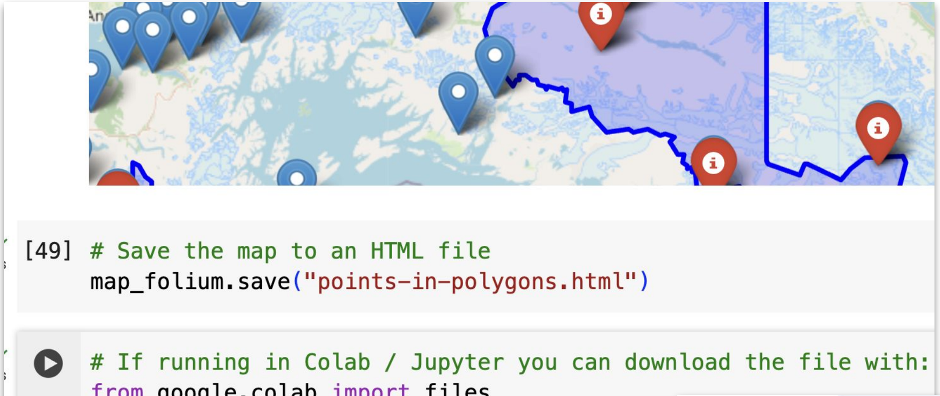


```
                fill_opacity=0.1,
                popup=f"Polygon: {row['Unit_Name
            ).add_to(map_folium)

    # Display the folium map (outside the loop)
    map_folium
```



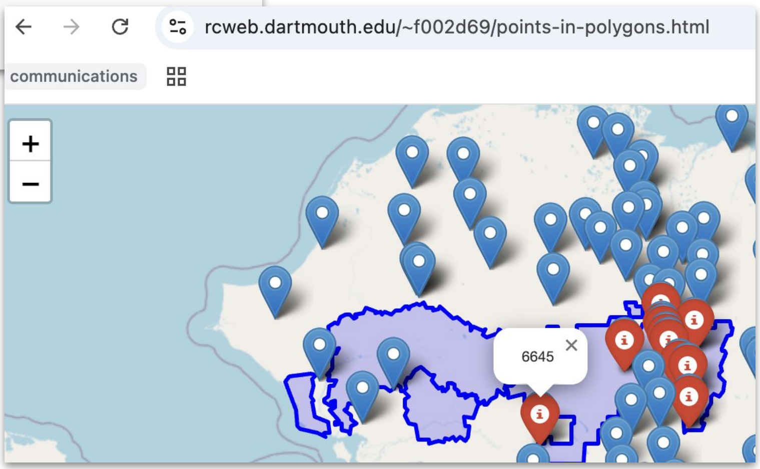
```
[48]
        # Add a marker to the map
        folium.Marker([lat, lon], icon=folium.Icon(color="red"
    #               icon=folium.Icon(color="red"),

    map_folium
```

Make a web map!



```
[49] # Save the map to an HTML file
     map_folium.save("points-in-polygons.html")
```

```
# If running in Colab / Jupyter you can download the file with:
from google.colab import files
files.download("points-in-polygons.html")
```

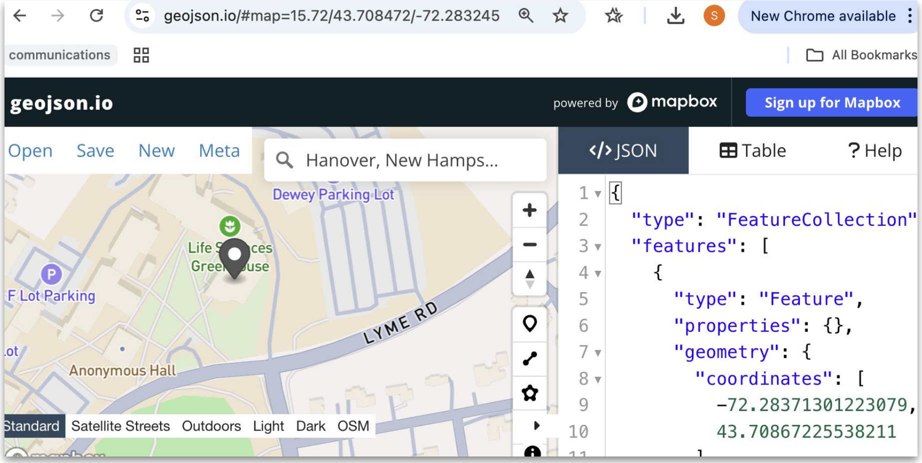


rcweb.dartmouth.edu/~f002d69/points-in-polygons.html

- Copy over to DartFS public_html folder
- https://rcweb.dartmouth.edu/~f002d69/points-in-polygons.html
- Don't have DartFS yet? Navigate to https://dashboard.dartmouth.edu/ to request account and specify that you want a public_html folder

Web map example

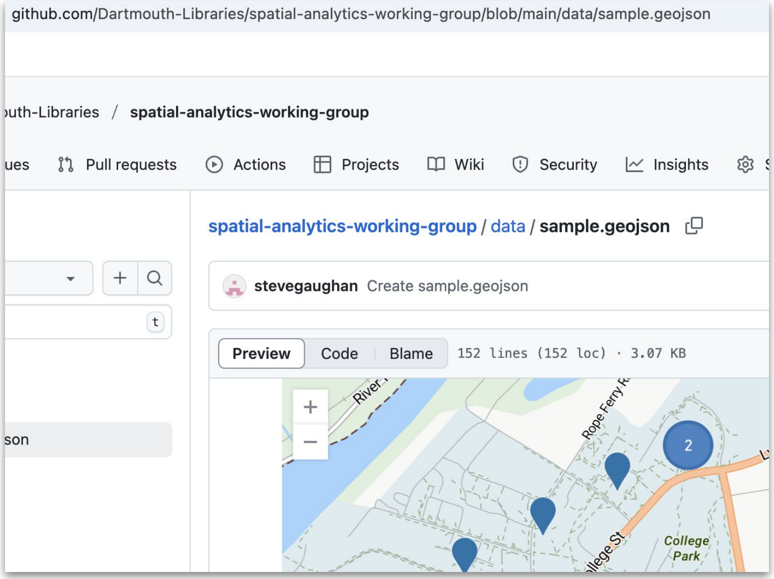
- https://rcweb.dartmouth.edu/~f002d69/geospatial/geospatial/dev/index-dev.html
- geojson.io



```
{
  "type": "FeatureCollection"
  "features": [
    {
      "type": "Feature",
      "properties": {},
      "geometry": {
        "coordinates": [
          -72.28371301223079,
          43.70867225538211
```

Geojson format & Github

- Geojson & Github
- https://github.com/Dartmouth-Libraries/spatial-analytics-working-group/blob/main/data/sample.geojson



github.com/Dartmouth-Libraries/spatial-analytics-working-group/blob/main/data/sample.geojson

uth-Libraries / spatial-analytics-working-group

spatial-analytics-working-group / data / sample.geojson

stevegaughan Create sample.geojson

152 lines (152 loc) · 3.07 KB

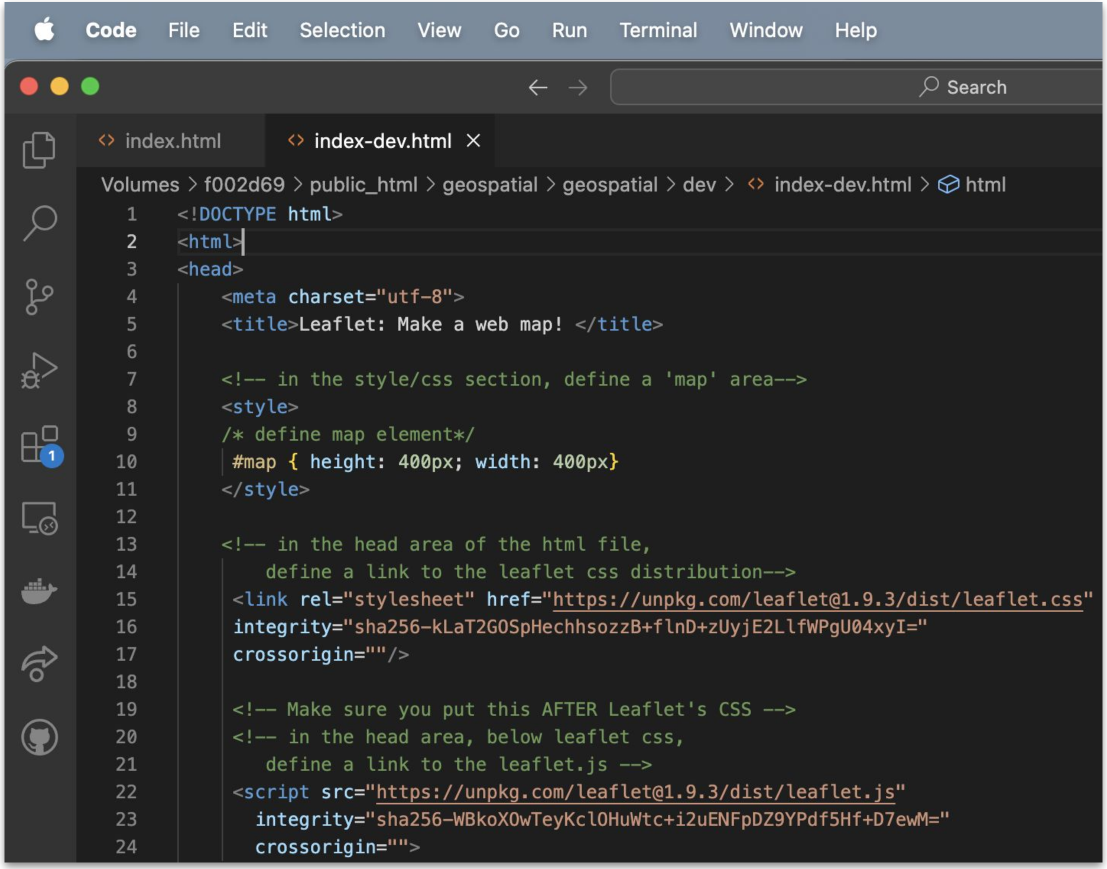
geojson:

```
{
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "properties": {
        "name": "LSC",
        "descrp": "LEED Platinum 2011"
      },
      "geometry": {
        "coordinates": [
          -72.28385852213658,
          43.70906927627746
        ],
        "type": "Point"
      },
      "id": 0
    },
    {
      "type": "Feature",
```

source: https://pro.arcgis.com/en/pro-app/latest/help/analysis/geoprocessing/modelbuilder/what-is-modelbuilder-.htm

HTML & Javascript

- HTML
- Javascript
- leaflet.js
- VS Code or other interpreter
- DartFS RCWeb

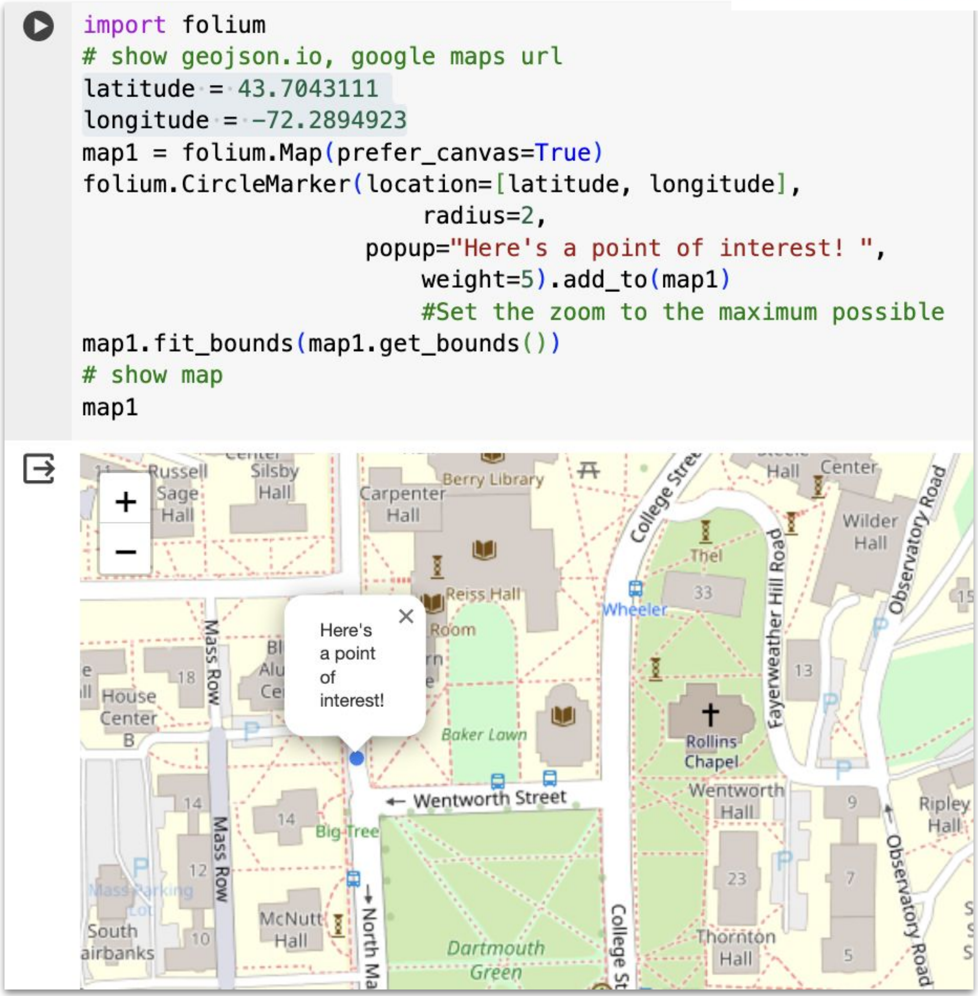

Code
File
Edit
Selection
View
Go
Run
Terminal
Window
Help
Search
index.html
index-dev.html
Volumes > f002d69 > public_html > geospatial > geospatial > dev > index-dev.html > html
1

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8">
    <title>Leaflet: Make a web map! </title>

    <!-- in the style/css section, define a 'map' area-->
    <style>
    /* define map element*/
     #map { height: 400px; width: 400px}
    </style>

    <!-- in the head area of the html file,
        define a link to the leaflet css distribution-->
     <link rel="stylesheet" href="https://unpkg.com/leaflet@1.9.3/dist/leaflet.css"
     integrity="sha256-kLaT2GOSpHechhsozzB+flnD+zUyjE2LlfWPgU04xyI="
     crossorigin=""/>

     <!-- Make sure you put this AFTER Leaflet's CSS -->
     <!-- in the head area, below leaflet css,
        define a link to the leaflet.js -->
     <script src="https://unpkg.com/leaflet@1.9.3/dist/leaflet.js"
       integrity="sha256-WBkoXOwTeyKclOHuWtc+i2uENFpDZ9YPdf5Hf+D7ewM="
       crossorigin="">
```

Python

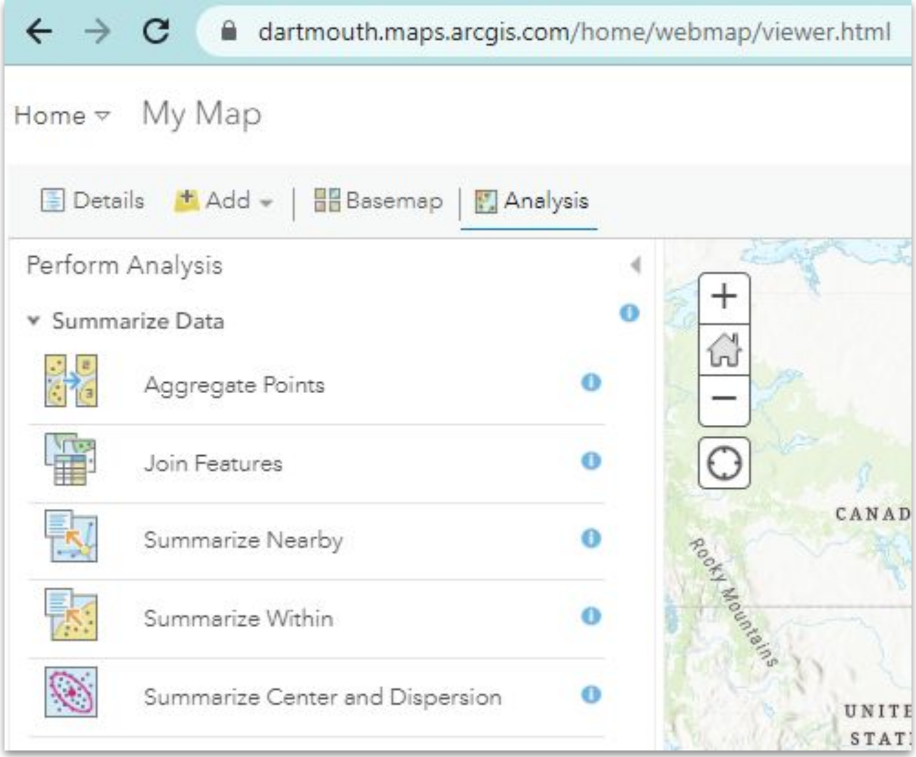
Jupyter Notebooks, Google Colab, etc

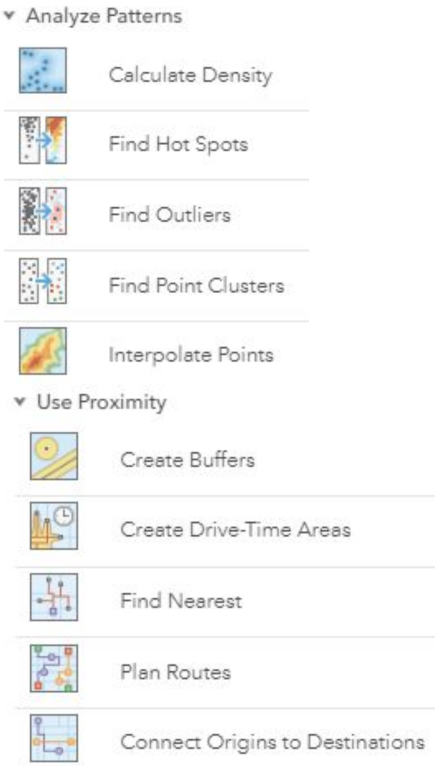
```
import folium
latitude = 42.3
longitude = -71
map1 = folium.Map(prefer_canvas=True)
folium.CircleMarker(location=[latitude,
longitude],
            radius=2,
            weight=5).add_to(map1)
#Set the zoom to the maximum possible
map1.fit_bounds(map1.get_bounds())
# show map
map1
```



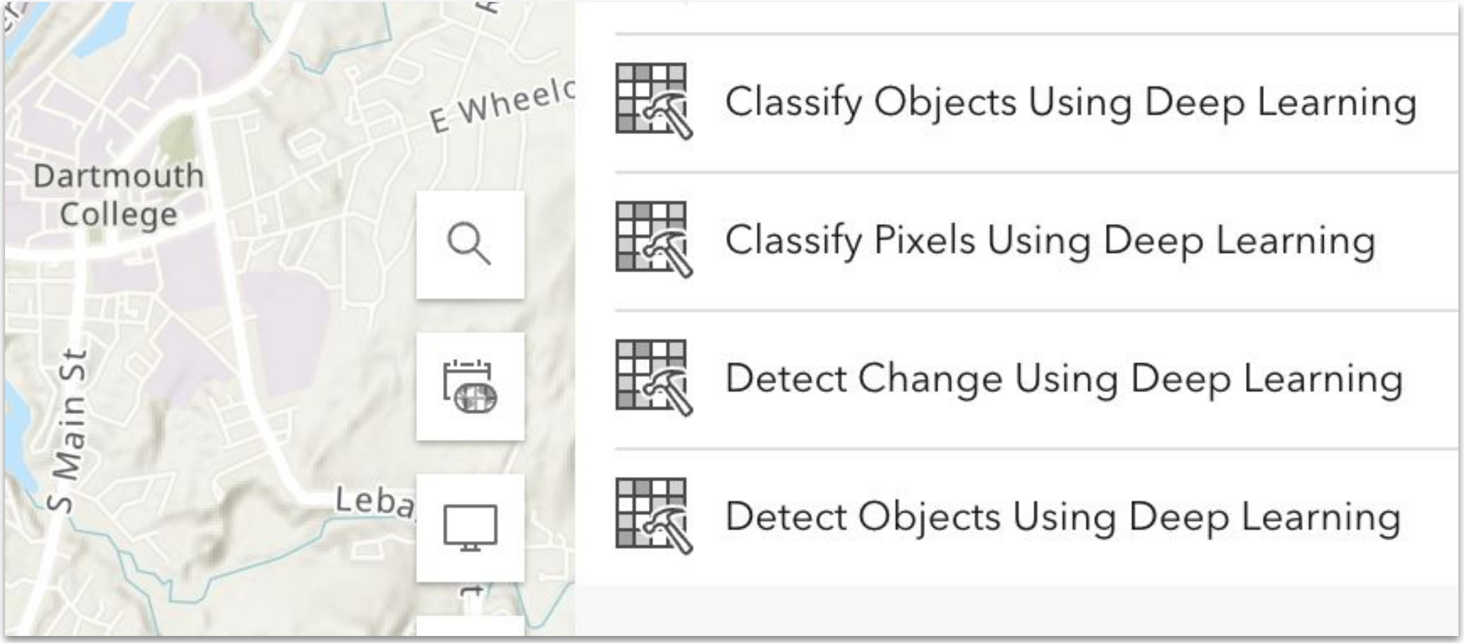
```
import folium
# show geojson.io, google maps url
latitude = 43.7043111
longitude = -72.2894923
map1 = folium.Map(prefer_canvas=True)
folium.CircleMarker(location=[latitude, longitude],
                        radius=2,
                    popup="Here's a point of interest! ",
                        weight=5).add_to(map1)
                        #Set the zoom to the maximum possible
map1.fit_bounds(map1.get_bounds())
# show map
map1
```

Analysis Tools





AI, Deep Learning - Analysis Tools



Dartmouth College
E Wheelo
S Main St
Leba
Classify Objects Using Deep Learning
Classify Pixels Using Deep Learning
Detect Change Using Deep Learning
Detect Objects Using Deep Learning

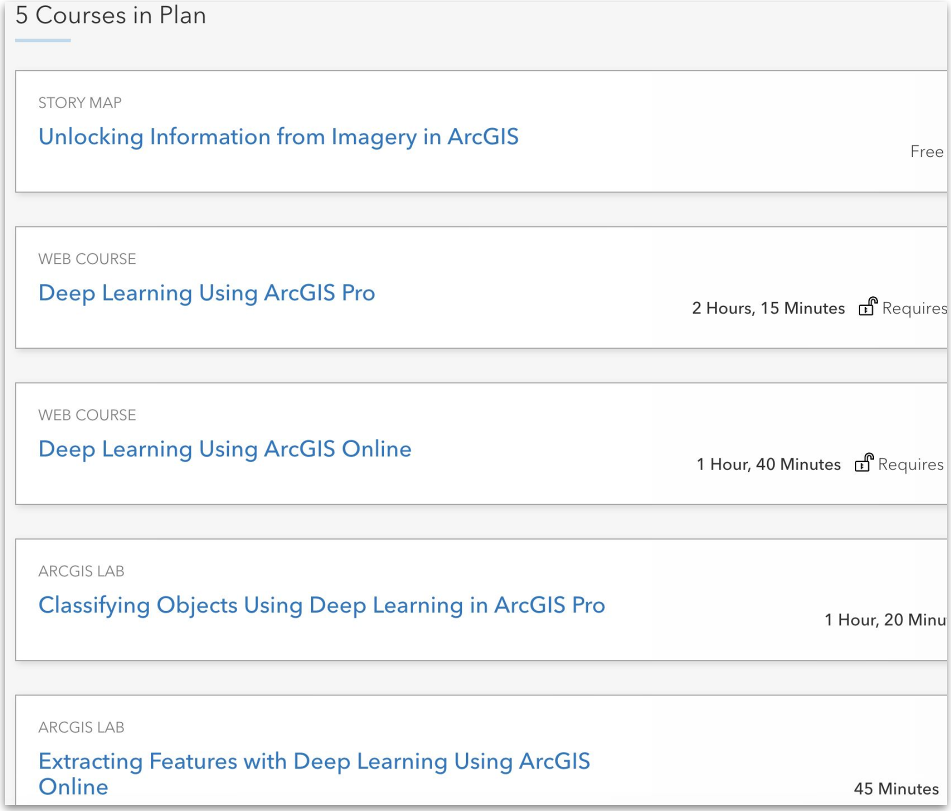
DARTMOUTH

AI, Deep Learning new training modules from ESRI

ArcGIS / ESRI

AI Learning plan & new Courses

See https://www.esri.com/training/catalog/5eb18cf2a7a78b65b7e26134/deep-learning-using-arcgis/



5 Courses in Plan

STORY MAP
Unlocking Information from Imagery in ArcGIS
Free

WEB COURSE
Deep Learning Using ArcGIS Pro
2 Hours, 15 Minutes Requires

WEB COURSE
Deep Learning Using ArcGIS Online
1 Hour, 40 Minutes Requires

ARCGIS LAB
Classifying Objects Using Deep Learning in ArcGIS Pro
1 Hour, 20 Minu

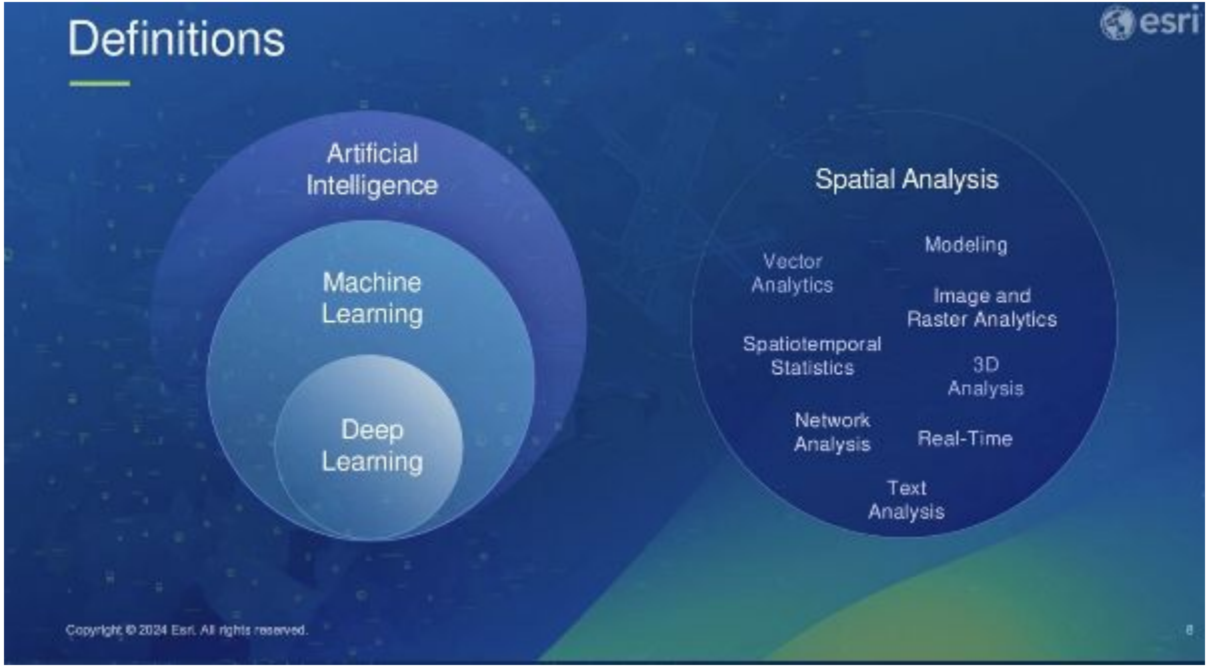
ARCGIS LAB
Extracting Features with Deep Learning Using ArcGIS Online
45 Minutes

AI, Deep Learning - Analysis Tools

ArcGIS Pro (and ArcMap before it) have had machine learning for many years

Tools to train image recognition patterns

Adding new deep learning and AI , new ways to solve spatial problems

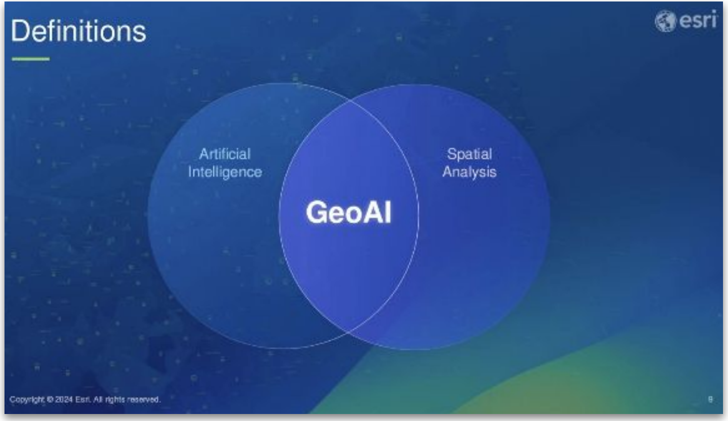


Source: Esri academy online modules ESRI

AI & Deep learning

- Use AI computer vision on satellite imagery, 3D imagery and video data
- Natural language processing on unstructured text data
- AI assistant to help search and find the proper tools and proper SQL queries
- New ways to solve geospatial problems
- New ways to assist the geospatial analyst with the software itself
- Pretrained AI models (from ESRI Living Atlas) or self-generated models

Pretrained models available to:
ArcGIS Pro
ArcGIS Online
ArcGIS API for Python
with the Arcgis.learn library
https://developers.arcgis.com/python/latest/api-reference/arcgis.learn.toc.html

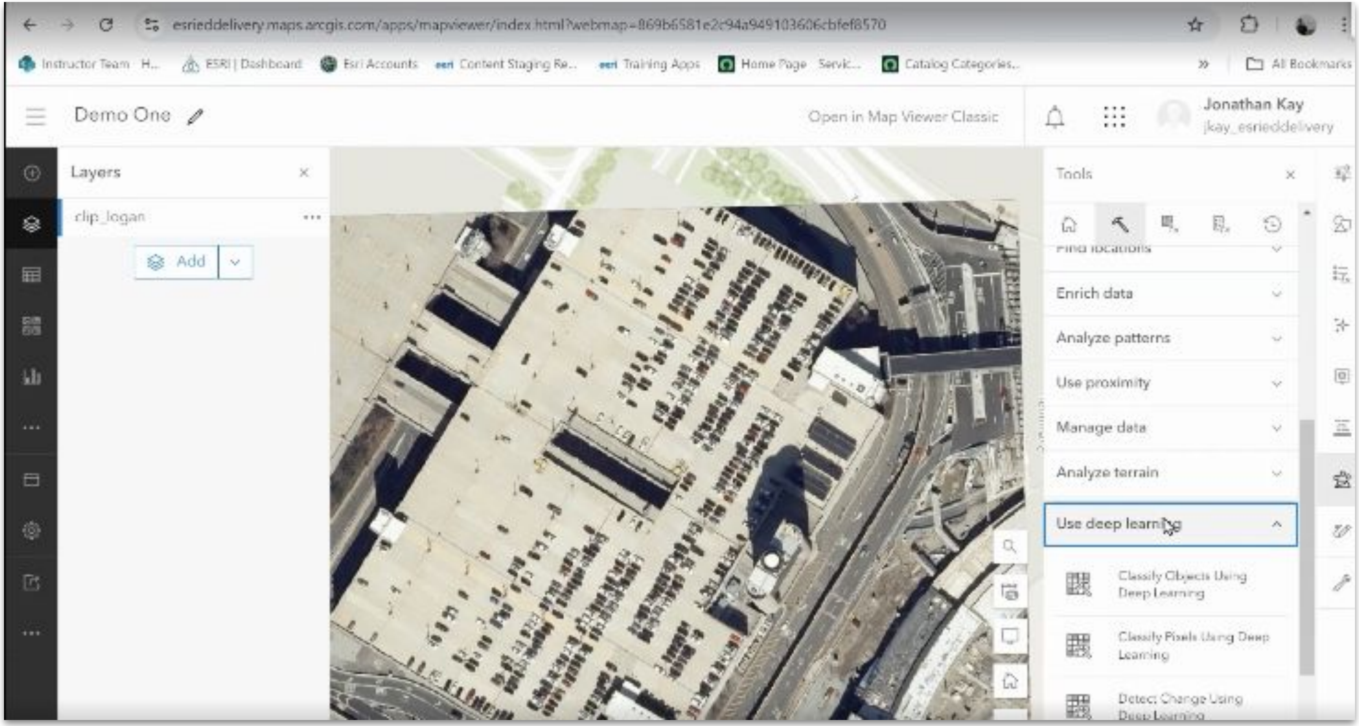


Definitions

Source: Esri academy online modules [ESRI]()

Can we count up the number of cars in this satellite image?

- 30cm x 30cm resolution satellite image, Logan Airport
- extract cars
- Create featureclass
- Count manually?
- Traditional tools?

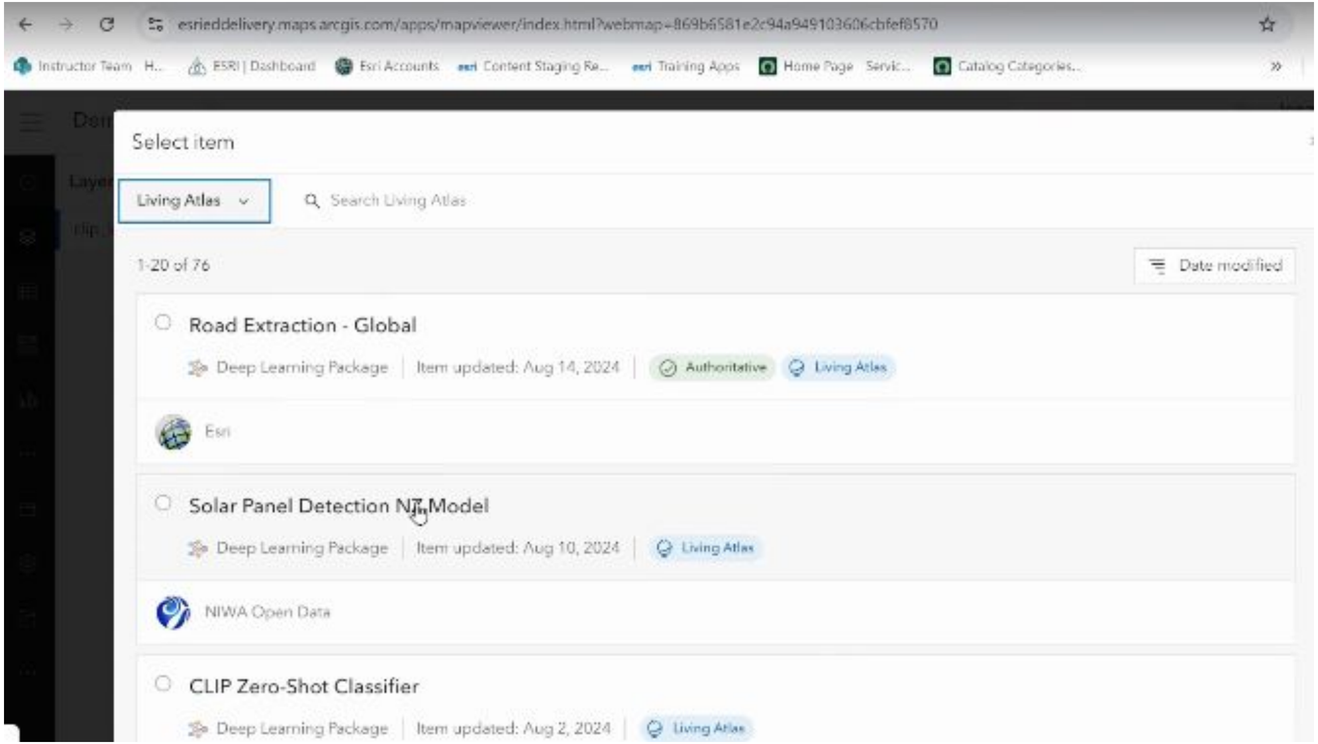


Source: Esri academy online modules ESRI

AI, Deep Learning - Analysis Tools

- Note that these tools are not finding the cars by pixel colors like we might do with a land cover map and machine learning, but rather by what the AI pretrained model has been told is a 'car' in many other satellite photos
- Note also, available in ArcGIS Online

Deep Learning pre-built models at ESRI's living atlas site



Select item

1-20 of 76

○ Road Extraction - Global

Deep Learning Package | Item updated: Aug 14, 2024 | Authoritative Living Atlas

Esri

○ Solar Panel Detection NZ Model

Deep Learning Package | Item updated: Aug 10, 2024 | Living Atlas

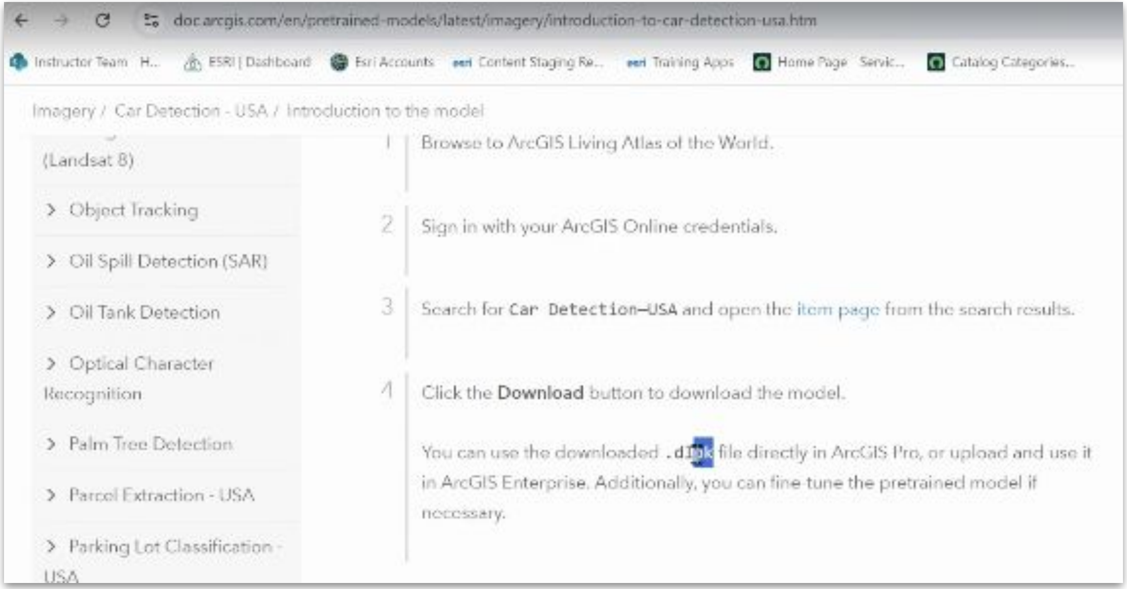
NIWA Open Data

○ CLIP Zero-Shot Classifier

Deep Learning Package | Item updated: Aug 2, 2024 | Living Atlas

Source: Esri academy online modules ESRI

Deep learning model access



doc.arcgis.com/en/pretrained-models/latest/imagery/introduction-to-car-detection-usa.htm
Instructor Team H...
ESRI | Dashboard
Esri Accounts
Content Staging Re...
Training Apps
Home Page
Servic...
Catalog Categories...
Imagery / Car Detection - USA / Introduction to the model
(Landsat 8)
Object Tracking
Oil Spill Detection (SAR)
Oil Tank Detection
Optical Character Recognition
Palm Tree Detection
Parcel Extraction - USA
Parking Lot Classification - USA

1 Browse to ArcGIS Living Atlas of the World.

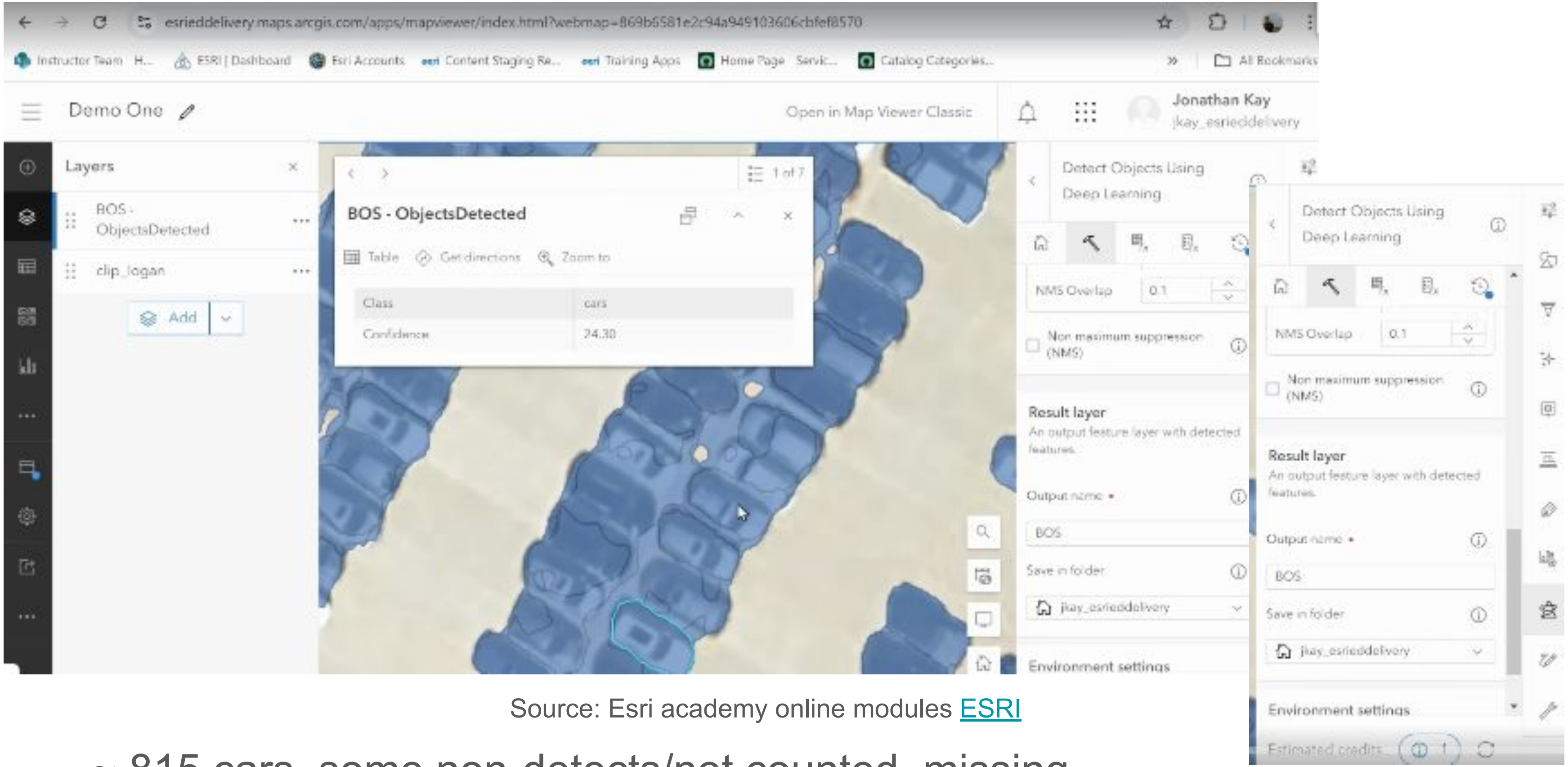
2 Sign in with your ArcGIS Online credentials.

3 Search for `Car Detection—USA` and open the item page from the search results.

4 Click the **Download** button to download the model.

You can use the downloaded `.dlpk` file directly in ArcGIS Pro, or upload and use it in ArcGIS Enterprise. Additionally, you can fine tune the pretrained model if necessary.

Source: Esri academy online modules ESRI



BOS - ObjectsDetected

Class	cars
Confidence	24.30

NMS Overlap 0.1

Output name • BOS

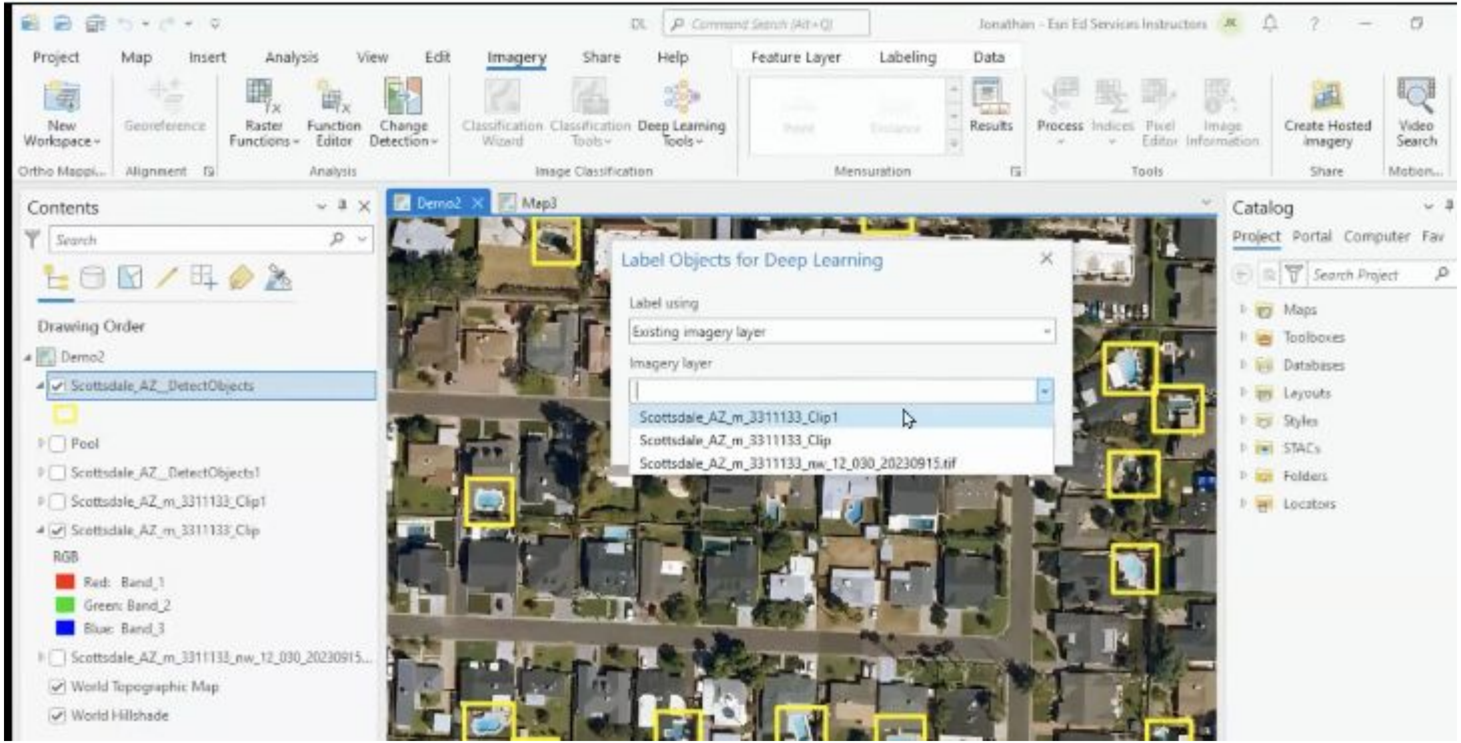
Save in folder jkay_esrieddelivery

Source: Esri academy online modules ESRI

- ~ 815 cars, some non-detects/not counted, missing

ArcGIS Pro AI tools

- Investigate aerial / satellite photos to detect swimming pools



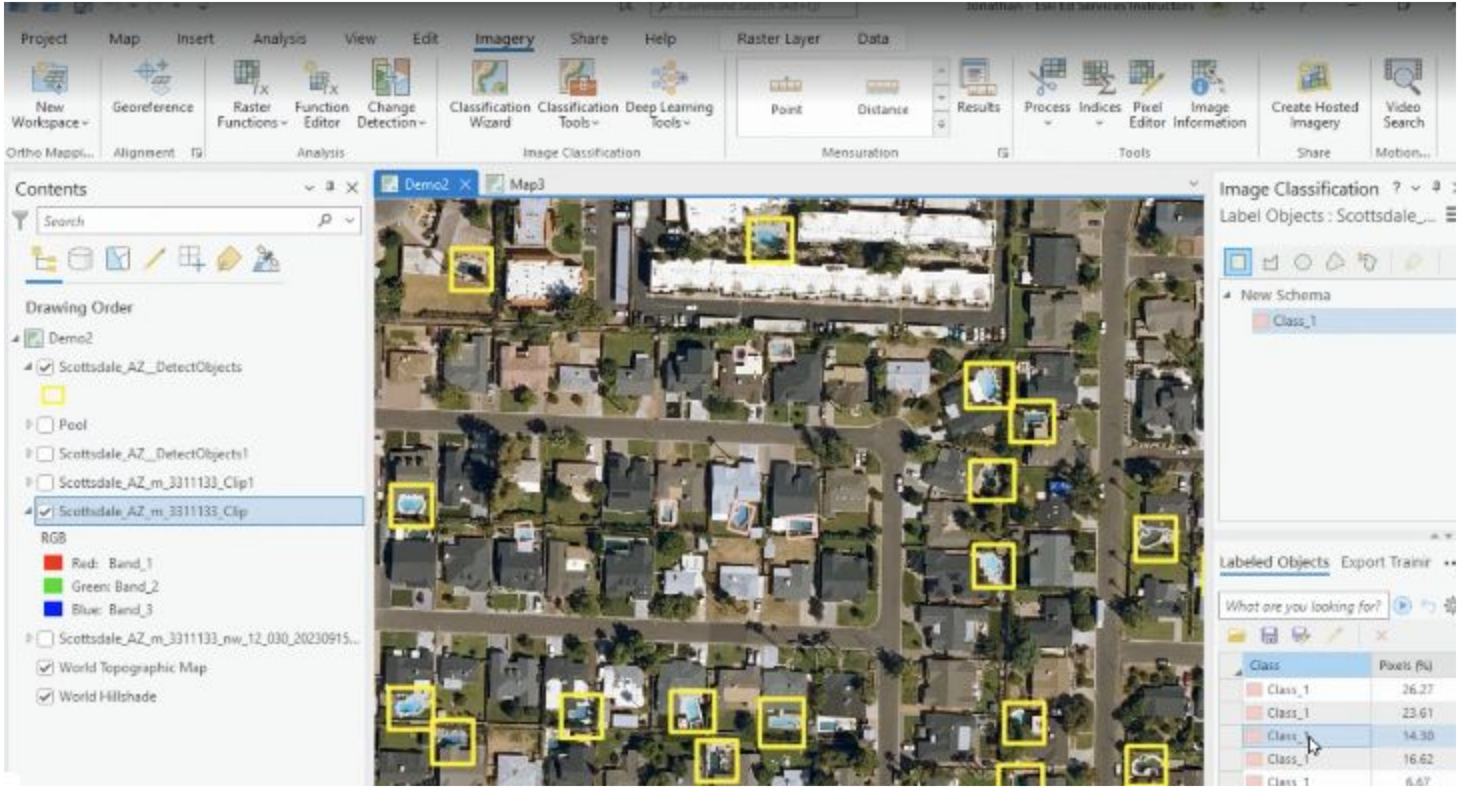
Label Objects for Deep Learning

Label using: Existing imagery layer

Imagery layer:

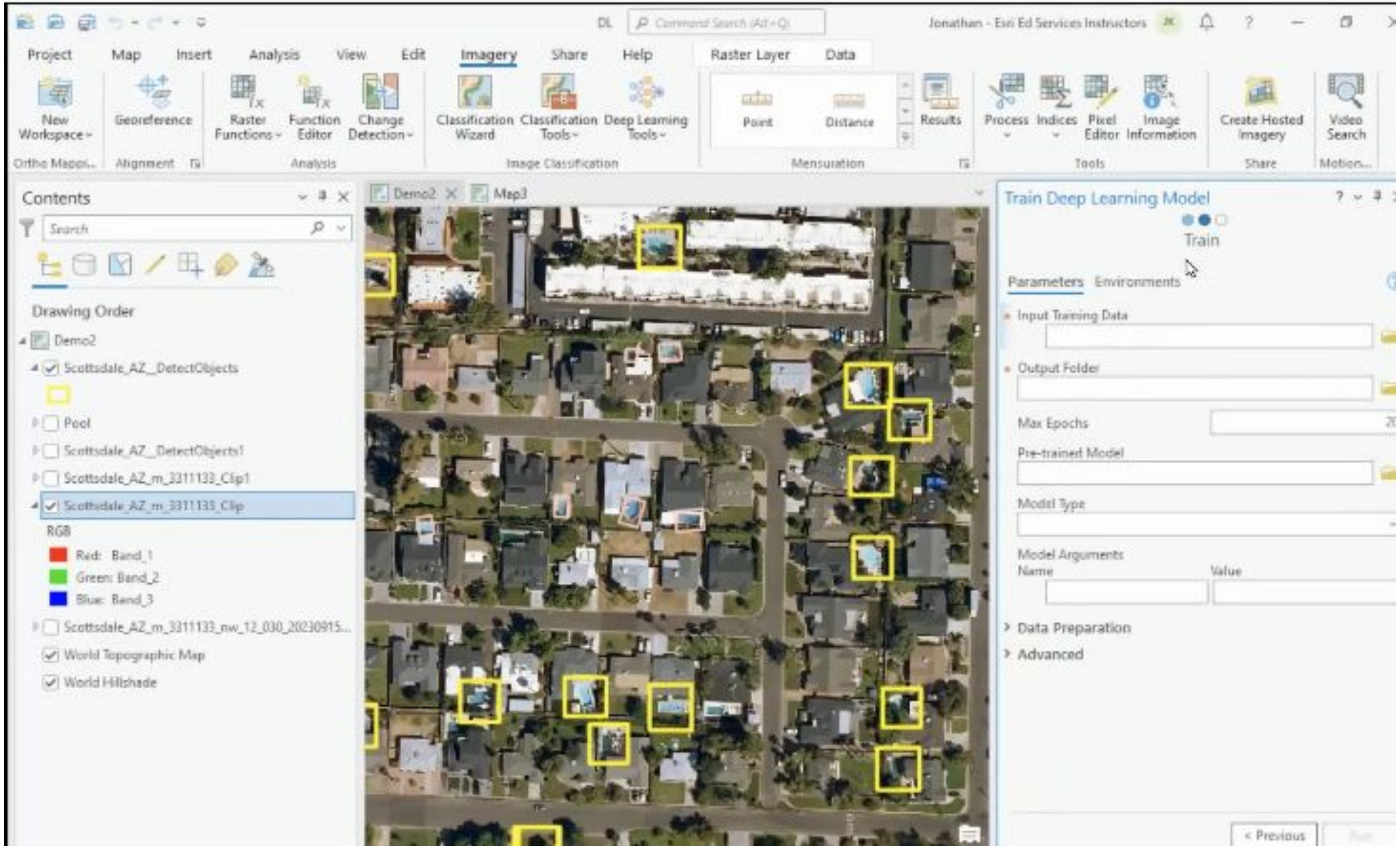
- Scottsdale_AZ_m_3311133_Clip1
- Scottsdale_AZ_m_3311133_Clip
- Scottsdale_AZ_m_3311133_nw_12_030_20230915.tif

Source: Esri academy online modules ESRI



Class	Pixels (%)
Class_1	26.27
Class_1	23.61
Class_1	14.30
Class_1	16.62
Class_1	6.67

Source: Esri academy online modules ESRI



Contents

Search

Drawing Order

- Demo2
  - ☑ Scottsdale_AZ_DetectObjects
  - □ Pool
  - □ Scottsdale_AZ_DetectObjects1
  - □ Scottsdale_AZ_m_3311133_Clip1
  - ☑ Scottsdale_AZ_m_3311133_Clip
    - RGB
    - 🟥 Red: Band_1
    - 🟩 Green: Band_2
    - 🟦 Blue: Band_3
  - □ Scottsdale_AZ_m_3311133_nw_12_030_20230915...
  - ☑ World Topographic Map
  - ☑ World Hillshade

Train Deep Learning Model

Input Training Data

Output Folder

Max Epochs 20

Pre-trained Model

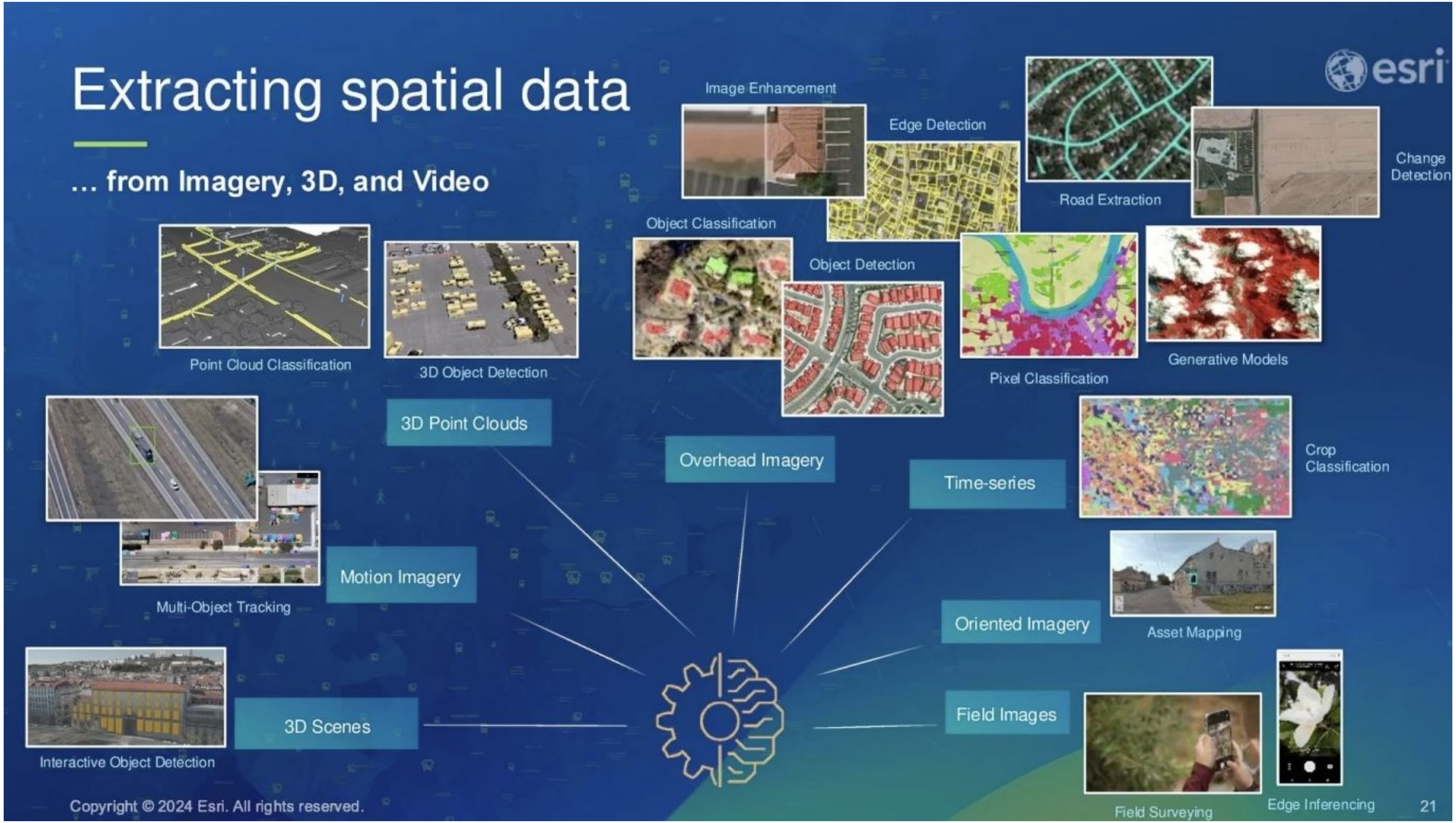
Model Type

Model Arguments

Name	Value

Source: Esri academy

online modules ESRI



Extracting spatial data

… from Imagery, 3D, and Video

Image Enhancement

Edge Detection

Road Extraction

Change Detection

Object Classification

Object Detection

Pixel Classification

Generative Models

Point Cloud Classification

3D Object Detection

3D Point Clouds

Overhead Imagery

Time-series

Crop Classification

Multi-Object Tracking

Motion Imagery

Oriented Imagery

Asset Mapping

Interactive Object Detection

3D Scenes

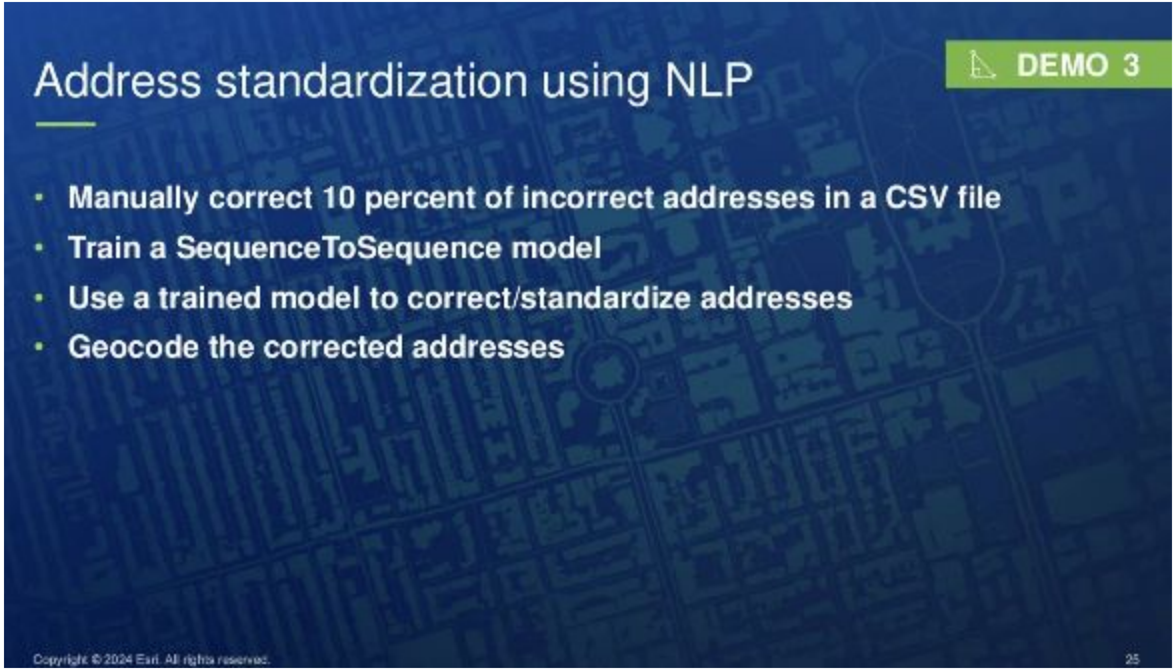
Field Images

Field Surveying

Edge Inferencing

21

Source: Esri academy online modules ESRI



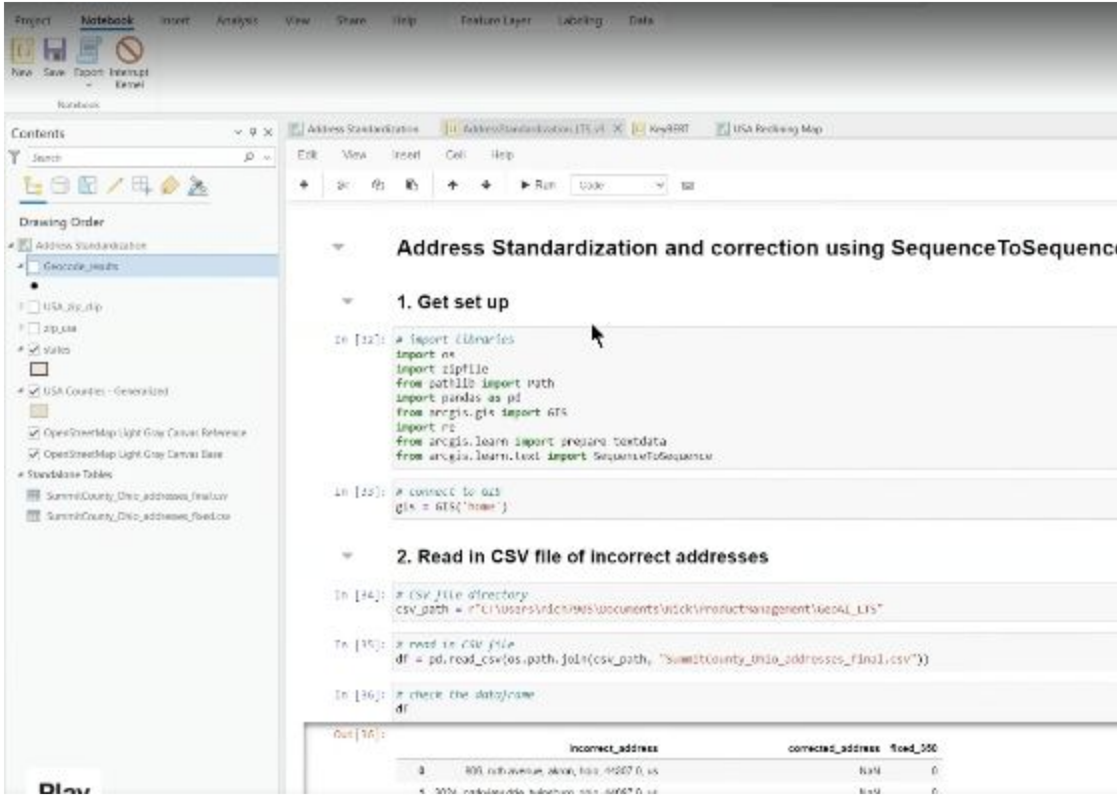
Address standardization using NLP

DEMO 3

- Manually correct 10 percent of incorrect addresses in a CSV file
- Train a SequenceToSequence model
- Use a trained model to correct/standardize addresses
- Geocode the corrected addresses

Source: Esri academy online modules ESRI

- Table of 3500 addresses
- AI NLP deep learning
- Manually correct about 300 to 350, about 10% of the total



Address Standardization and correction using SequenceToSequenc

1. Get set up

```
In [32]: # import libraries
         import os
         import zipfile
         from pathlib import Path
         import pandas as pd
         from arcgis.gis import GIS
         import re
         from arcgis.learn import prepare_textdata
         from arcgis.learn.text import SequenceToSequence
```

```
In [33]: # connect to GIS
         gis = GIS('home')
```

2. Read in CSV file of incorrect addresses

```
In [34]: # CSV file directory
         csv_path = r"C:\Users\[illegible]\Documents\[illegible]\ProductManagement\GeoAI_LTS"
```

```
In [35]: # read in CSV file
         df = pd.read_csv(os.path.join(csv_path, "SummitCounty_Ohio_addresses_final.csv"))
```

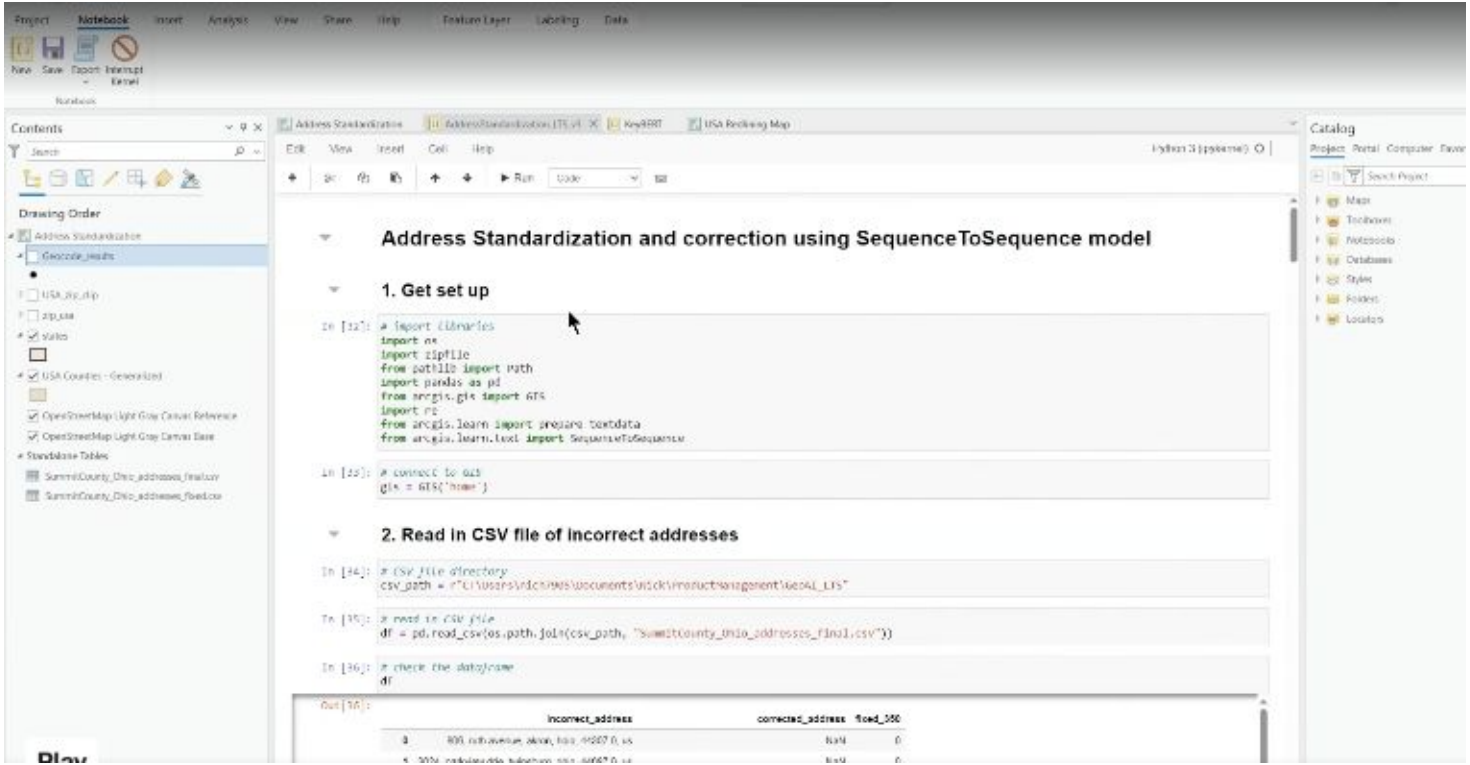
```
In [36]: # check the dataframe
         df
```

```
Out[36]:
                      incorrect_address      corrected_address  fixed_350
   3    806 [illegible] avenue, akron, [illegible] 44307.0, us   NaN   0
   5  2024 [illegible] 44067.0, us                               NaN   0
```

Source: Esri academy online modules ESRI

AI / deep learning to 'fix' incorrect addresses

- Python API



Address Standardization and correction using SequenceToSequence model

1. Get set up

```
In [32]: # import libraries
         import os
         import zipfile
         from pathlib import Path
         import pandas as pd
         from arcgis.gis import GIS
         import re
         from arcgis.learn import prepare_textdata
         from arcgis.learn.text import SequenceToSequence
```

```
In [33]: # connect to GIS
         gis = GIS('home')
```

2. Read in CSV file of incorrect addresses

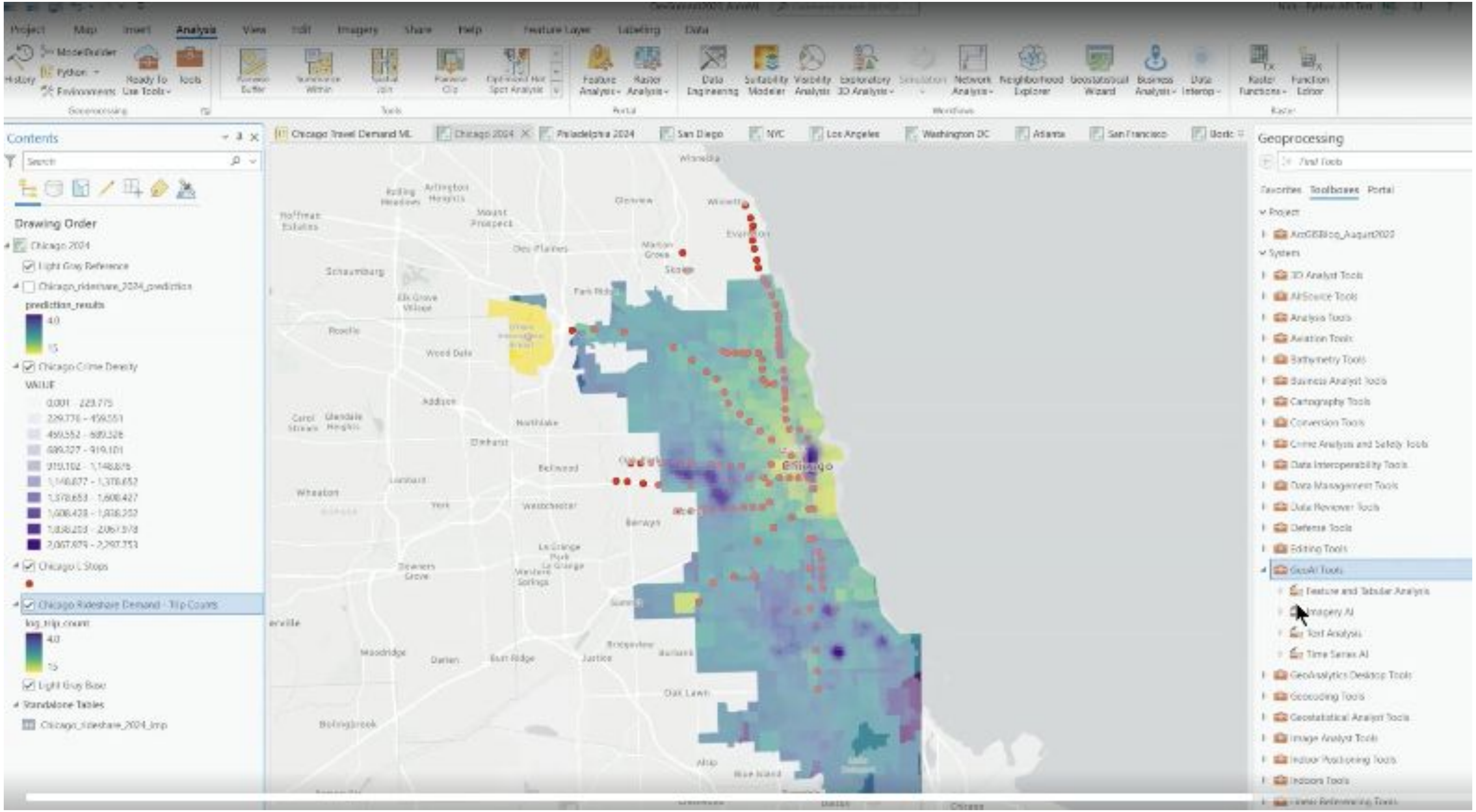
```
In [34]: # CSV file directory
         csv_path = r"C:\Users\rich9905\Documents\Rick\ProductManagement\GeoAI_LTS"
```

```
In [35]: # read in CSV file
         df = pd.read_csv(os.path.join(csv_path, "SummitCounty_Ohio_addresses_final.csv"))
```

```
In [36]: # check the dataframe
         df
```

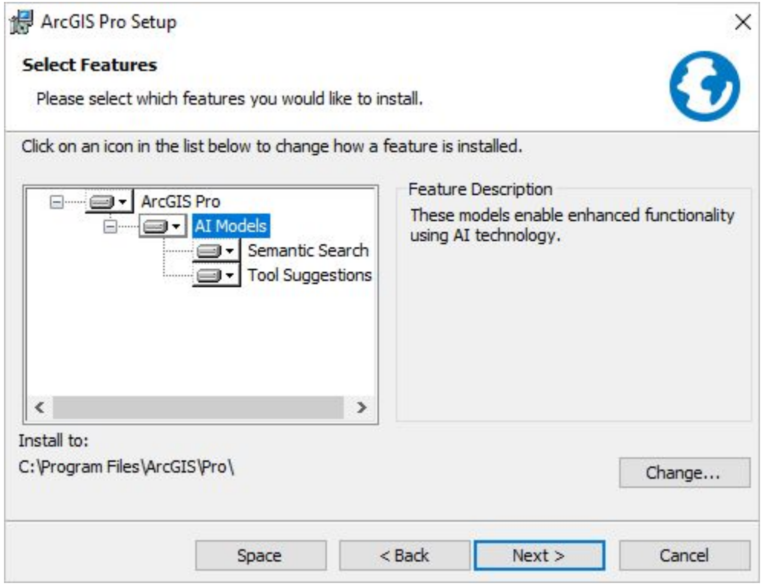
```
Out[36]:
                          incorrect_address      corrected_address   fixed_360
     0   808 ruth avenue, akron, hio, 44307.0, us           NaN           0
     1   3024 [illegible] twinsburg, [illegible] 44087.0, us NaN          0
```

Source: Esri academy online modules [ESRI]



Source: Esri academy online modules ESRI

- https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/ai-in-arcgis-pro-3-3
- https://pro.arcgis.com/en/pro-app/latest/help/analysis/ai/geoai.htm



ArcGIS Pro Setup

Select Features

Please select which features you would like to install.

Click on an icon in the list below to change how a feature is installed.

- ArcGIS Pro
  - AI Models
    - Semantic Search
    - Tool Suggestions

Feature Description

These models enable enhanced functionality using AI technology.

Install to:

C:\Program Files\ArcGIS\Pro\

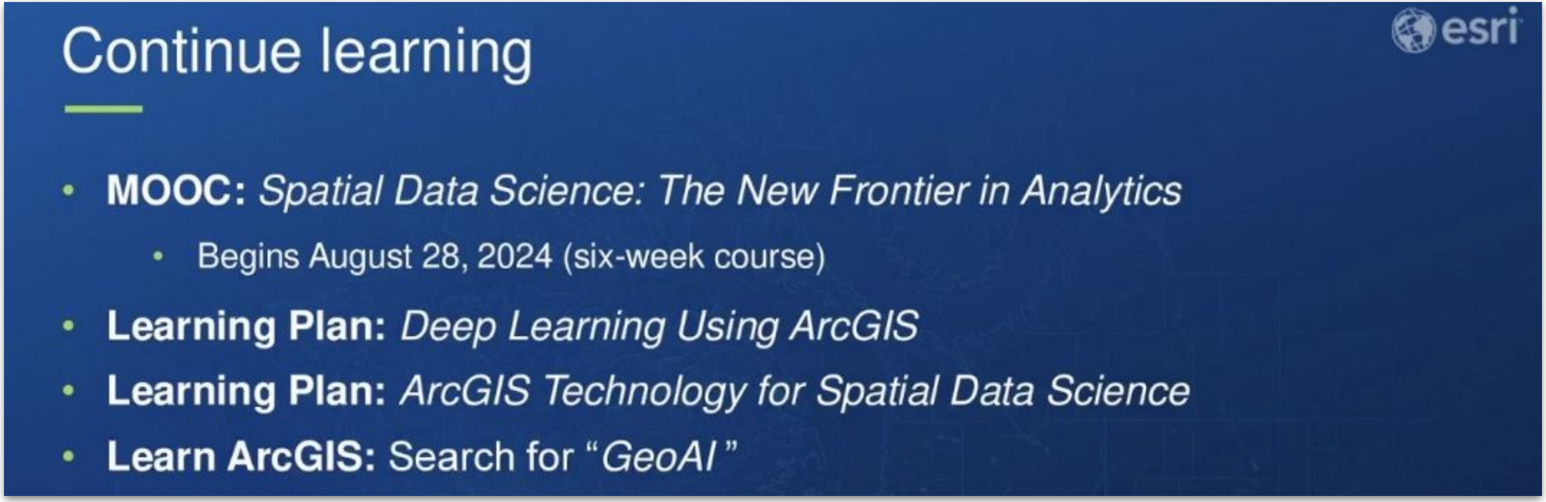
Source: Esri academy online modules ESRI

GeoAI
Helping Address Our Most Complex Challenges
Infrastructure
Economic Development
Pollution
Nature Conservation
Health
Energy
Business
Natural Resources
Climate Change
National Security
Science and Technology
Environment
Water Resources
Agriculture
Social Conflicts
Urbanization and Development
Transportation
Equity and Access
Natural Disasters
Networks and 5G
Understanding Our World
Enhancing Productivity
Innovating for a Sustainable Future

Source: Esri academy online modules [ESRI]

Learn more

- GeoAI, Deep Learning https://www.esri.com/training/catalog/5eb18cf2a7a78b65b7e26134/deep-learning-using-arcgis/



Continue learning

- **MOOC:** *Spatial Data Science: The New Frontier in Analytics*
  - Begins August 28, 2024 (six-week course)
- **Learning Plan:** *Deep Learning Using ArcGIS*
- **Learning Plan:** *ArcGIS Technology for Spatial Data Science*
- **Learn ArcGIS:** Search for "*GeoAI* "

Source: Esri academy online modules ESRI

Learn more

- https://www.esri.com/training/catalog/5eb18cf2a7a78b65b7e26134/deep-learning-using-arcgis/
- https://www.esri.com/training/catalog/5e4c5550a333e81cae8274f0/arcgis-technology-for-spatial-data-science/
- Combining AI and GIS powerful
- Vision to have GeoAI helpful to solve complex problems in the world today
- Do mundane tasks in a faster more efficient way
- Derive helpful insights using ai, ml, deep learning
- More productive, solve problems faster

Resources

- Geography Department, Earth Sciences
  - Geography https://geography.dartmouth.edu/
  - Earth Sci: https://earthsciences.dartmouth.edu/
- Dartmouth College ArcGIS Online (SSO sign on) https://dartmouth.maps.arcgis.com
- Dartmouth College Library
  - https://researchguides.dartmouth.edu/gis
  - https://researchguides.dartmouth.edu/gisdata
  - Research Data Services: https://researchguides.dartmouth.edu/data_management/organize-analyze
  - We help faculty, student, and staff researchers tidy and visualize research data.
  - For help, email us at researchdatahelp@groups.dartmouth.edu

Feedback

Thanks for coming to our workshop!

We want to now learn from you about how we continue to present relevant workshops in the best way we can.

Please take a minute or so to fill out our form with your constructive feedback, we can't wait to hear from you!

dartgo.org/feedback

dartgo.org/geospatial-event

Workshop links & demo data

ArcGIS Online https://dartgo.org/arcgisonline and ArcGIS Storymaps examples and log-in

https://dartgo.org/workshop-share

More sample data https://dartgo.org/gisdata (shared google drive folder)

https://www.naturalearthdata.com/downloads/110m-cultural-vectors/110m-admin-0-countries/

Research Guide:
https://researchguides.dartmouth.edu/c.php?g=59725&p=10932912&preview=ed741a5a5a0f134ef30af138466884b1

Github code & sample data:
https://github.com/Dartmouth-Libraries/spatial-analytics-working-group/tree/main

Questions?

As always, feel free to reach out anytime.

Thanks for attending our workshop!

Reproducible Spatial Analysis using Python

```
# note: Geojson.io https://geojson.io/#map=3.5/40.21/-73.53

# create a string variable for our results directory
Get files
# Tip: always comment your code!
# csv file can go into a regular 'pandas' dataframe for now
import pandas as pd
df_web =
pd.read_csv('https://rcweb.dartmouth.edu/homes/f002d69/workshops/data/bear-sightings.csv')
```

Reproducible Spatial Analysis using Python

```
from google.colab import files

# Upload the shapefile from your Mac desktop
uploaded = files.upload()
# upload 'nationalparks.zip' file downloaded from dartgo.org/python-spatial

# Get the file name
file_name = list(uploaded.keys())[0]

# Load the shapefile into geopandas 'geodataframe'
gdf = gpd.read_file(file_name)

# Display the first few rows of the geodataframe
print(gdf.head())
```

Reproducible Spatial Analysis using Python

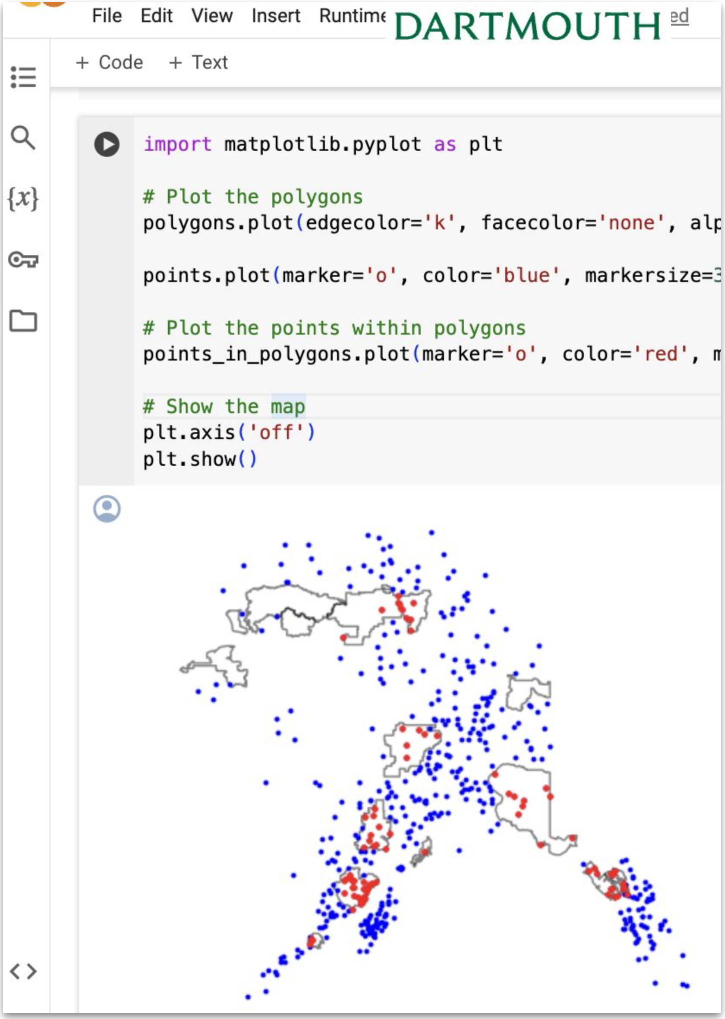
```
# rename this file polygons or parks
polygons = gdf
# convert the points to a spatial object

df = df_web
points = gpd.GeoDataFrame(
    df, geometry=gpd.points_from_xy(df.longitude, df.latitude)
)
# set the map projection for the points (using the polygon map project)
# note: https://epsg.io/4326
points.crs = 'EPSG:4326'  # Replace with the CRS of your data if different
# Reproject the points to match the CRS of the polygons
points = points.to_crs(polygons.crs)
```

Reproducible Spatial Analysis using Python

```
# do the overlay analysis points in polygons
points_in_polygons = gpd

# Point-in-polygon overlay
points_in_polygons = gpd.sjoin(points, polygons, predicate='within')
```

Reproducible Spatial Analysis using Python

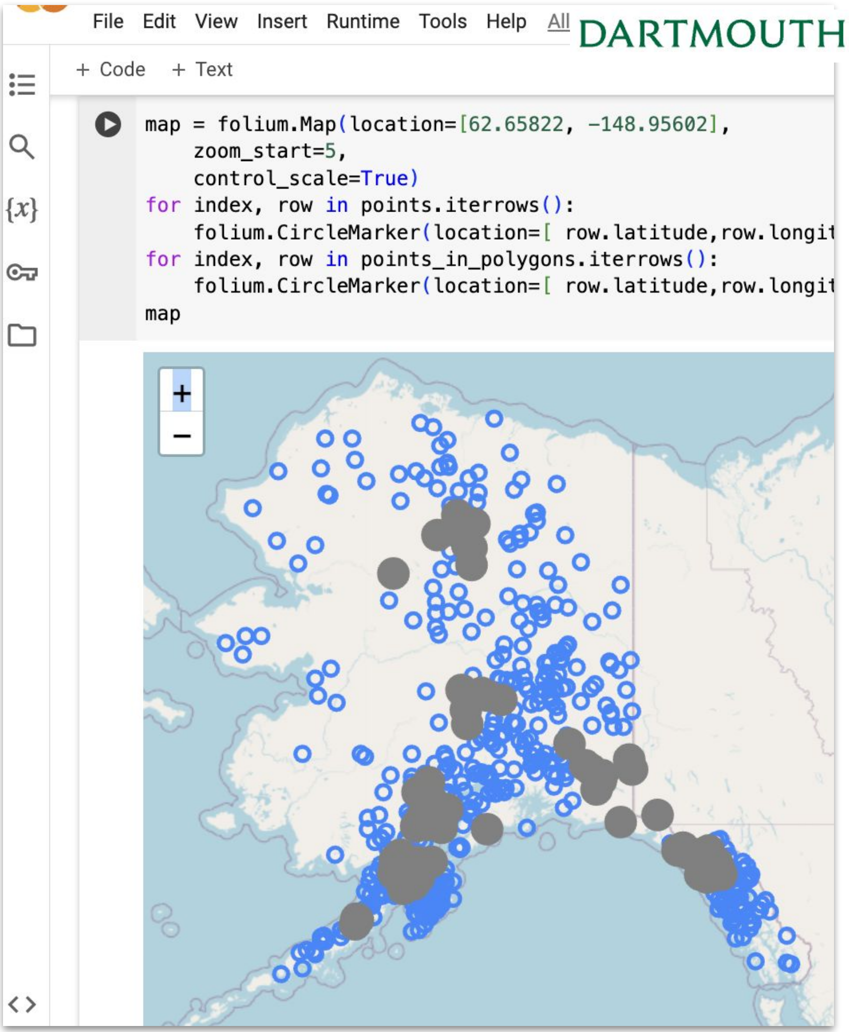
```
# plot the points and polygons
import matplotlib.pyplot as plt

polygons.plot(edgecolor='k', facecolor='none', alpha=0.5)
points.plot(marker='o', color='blue', markersize=3,
        ax=plt.gca())

# Plot the points within polygons
points_in_polygons.plot(marker='o',
        color='red', markersize=5, ax=plt.gca())

# Show the map
plt.axis('off')
plt.show()
```



```
import matplotlib.pyplot as plt

# Plot the polygons
polygons.plot(edgecolor='k', facecolor='none', alp

points.plot(marker='o', color='blue', markersize=3

# Plot the points within polygons
points_in_polygons.plot(marker='o', color='red', m

# Show the map
plt.axis('off')
plt.show()
```

Folium Basemaps

Plot using the 'folium' library with a Leaflet basemap such as Open Street Map



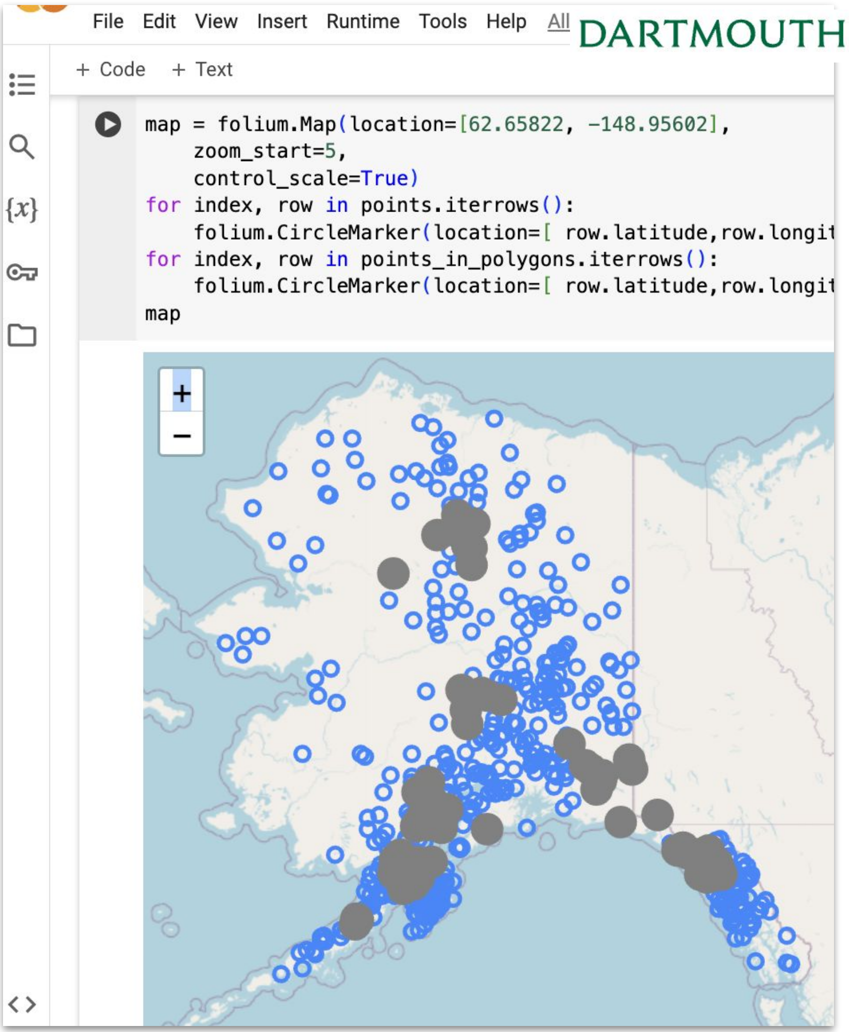
```
map = folium.Map(location=[62.65822, -148.95602],
    zoom_start=5,
    control_scale=True)
for index, row in points.iterrows():
    folium.CircleMarker(location=[ row.latitude,row.longit
for index, row in points_in_polygons.iterrows():
    folium.CircleMarker(location=[ row.latitude,row.longit
map
```

Spatial Analysis Visualization - Geographic Results

If all went well, map should look like this

Our analysis layer is shown

Our original datasets are still intact



```
map = folium.Map(location=[62.65822, -148.95602],
     zoom_start=5,
     control_scale=True)
for index, row in points.iterrows():
     folium.CircleMarker(location=[ row.latitude,row.longit
for index, row in points_in_polygons.iterrows():
     folium.CircleMarker(location=[ row.latitude,row.longit
map
```