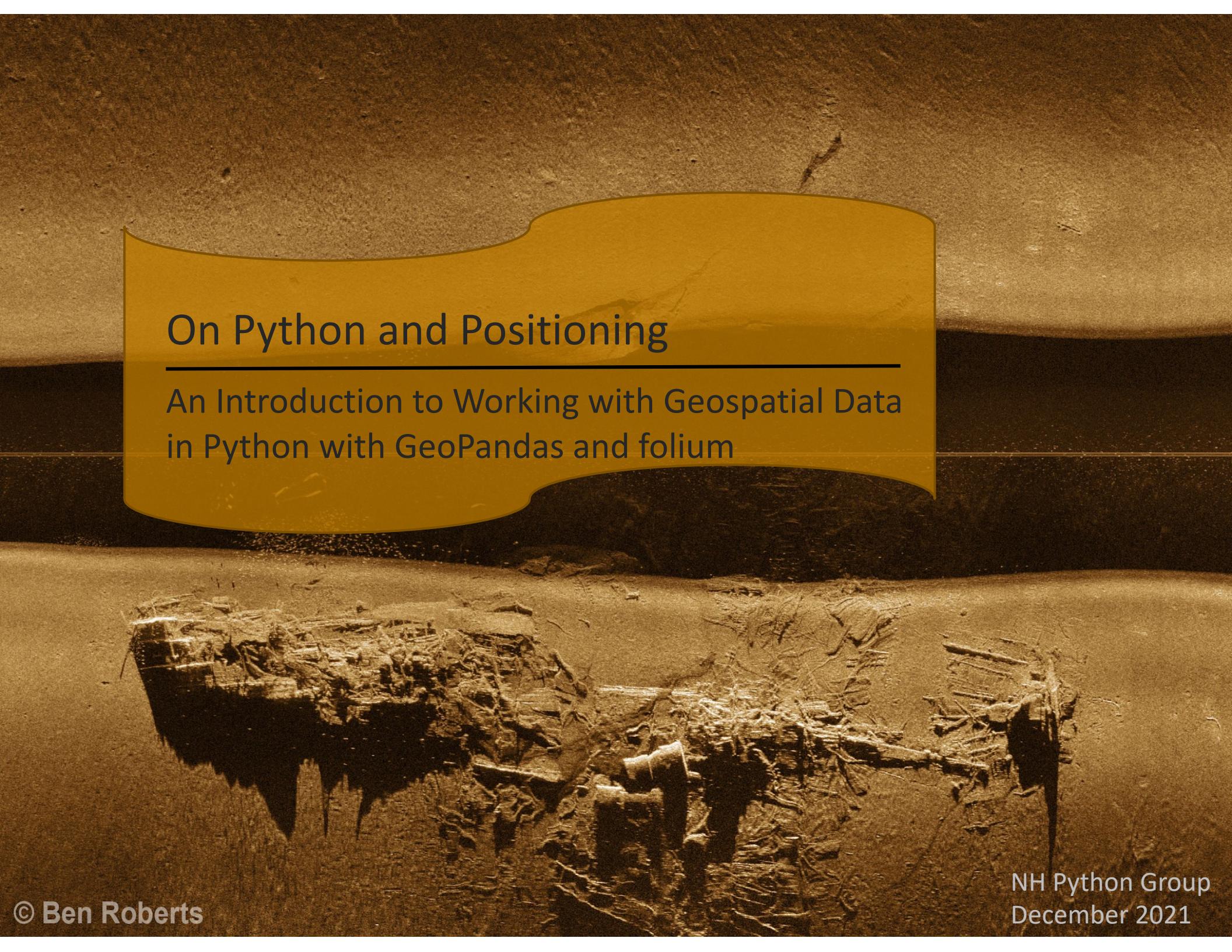


# On Python and Positioning

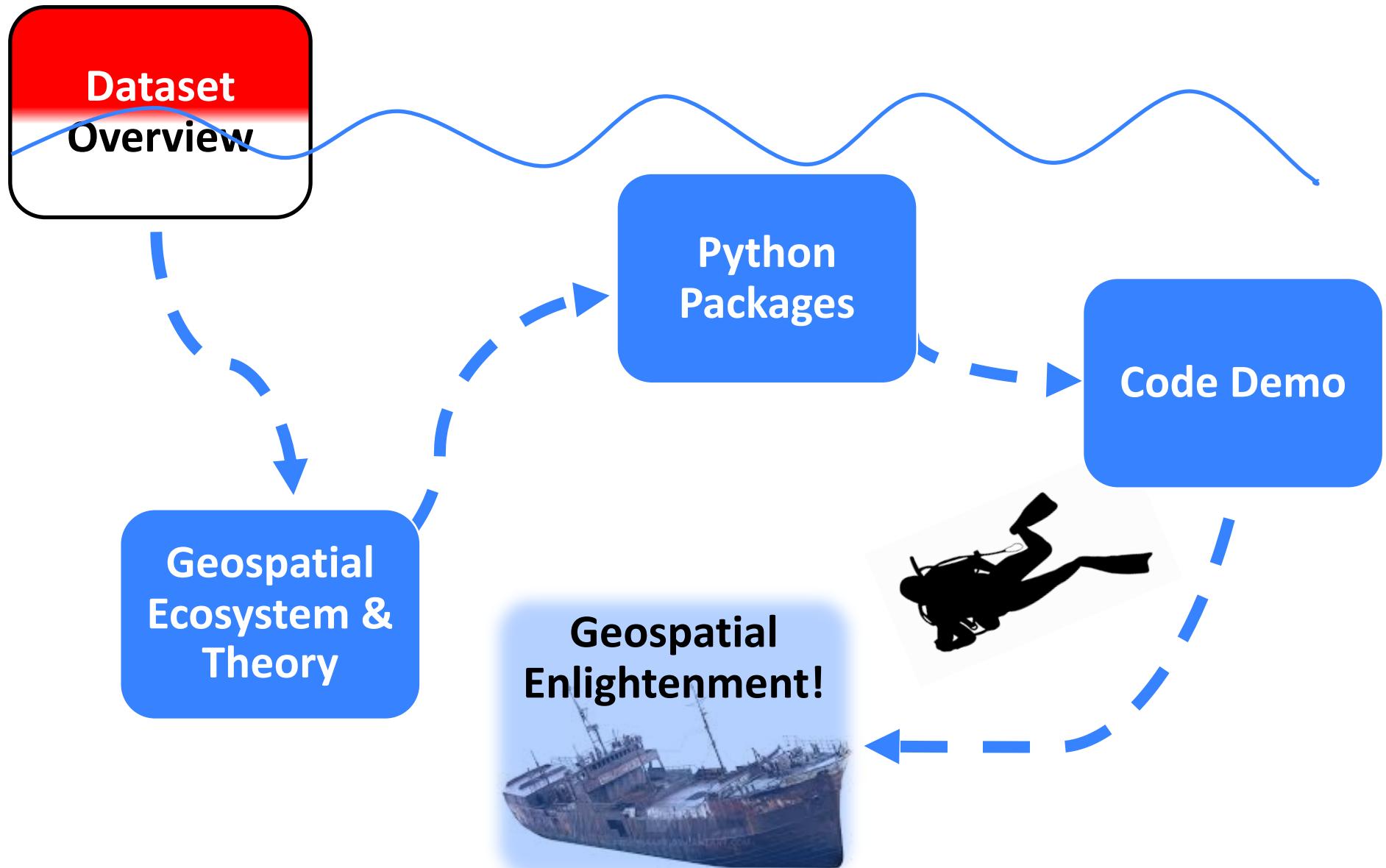
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An Introduction to Working with Geospatial Data  
in Python with GeoPandas and folium



# This Evening's Quest

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Sources:

- Cover photo: Sonar image of the SS Biela via Eastern Search & Survey © Ben Roberts, used with permission
- All clipart, except where noted, is from Clipart-library.com, licensed for personal use

# Dataset Overview

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**National Oceanic  
& Atmospheric  
Administration  
(NOAA)**

- ◆ Three public datasets of NOAA's collection of known wrecks and obstructions in US coastal waters
  - Automated Wreck and Obstruction Information System (AWOIS) wrecks, AWOIS obstructions, and Electronic Navigational Chart (ENC) wrecks
  - <https://nauticalcharts.noaa.gov/data/wrecks-and-obstructions.html>

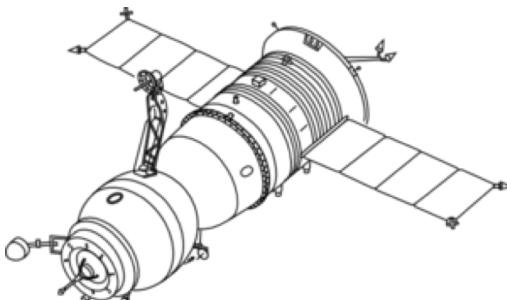
**Eastern Search &  
Survey (ESS)**

- ◆ ESS provided coordinates for several hang logs involved in the search for the SS Biela wreck, as well as details and backstory of the search
  - <https://www.facebook.com/Eastern-Search-Survey-109413857123876>

# The Geospatial Ecosystem: Geographic Information Systems (GIS)

A GIS is a computer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information – this can include hardware, software, data, people, and industry protocols<sup>1</sup>

## Data Collection



## Industry Protocols

- ◆ Open Geospatial Consortium (OGC)

## Data Storage



## GIS Software



- ◆ OSGeo Projects: GDAL/OGR, GEOS, PROJ

- ◆ Desktop Apps: QGIS, ArcGIS, others

- ◆ Python packages

## Note:

1. Bolstad, Paul. *GIS Fundamentals: a First Text on Geographic Information Systems*. 6th ed., XanEdu, 2019.

# Geospatial Data Models

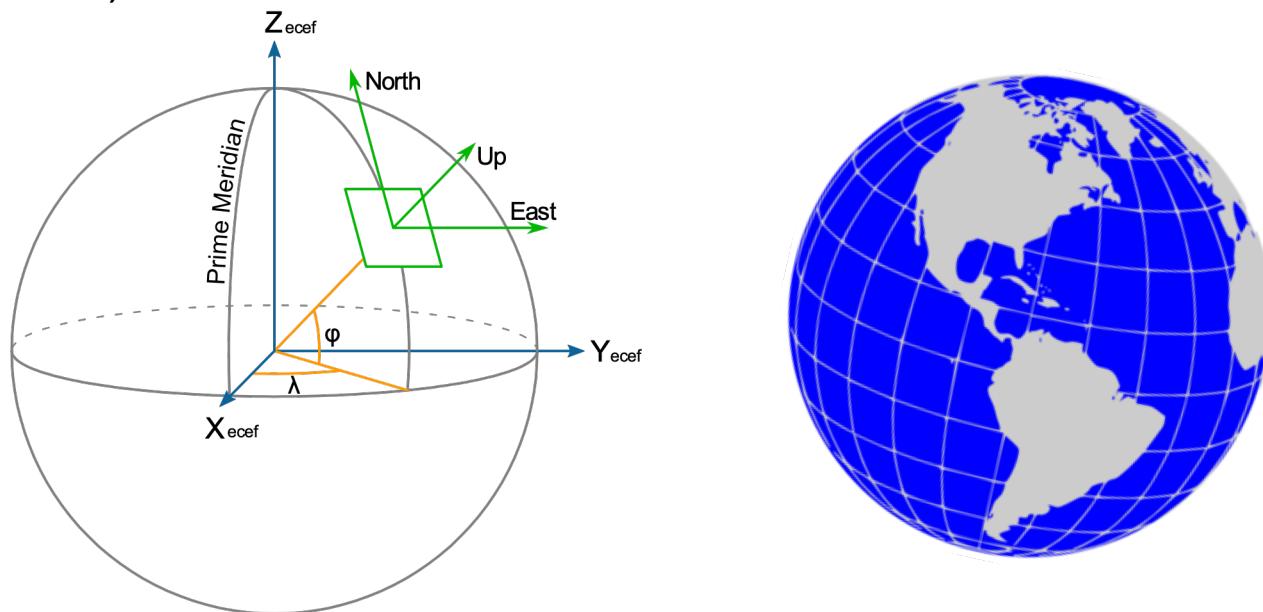
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	Description	File Format Examples
Vector	<ul style="list-style-type: none"><li>• Discrete geometries</li><li>• Points, lines, polygons described by coordinates</li></ul>	<ul style="list-style-type: none"><li>• Shapefile (.shp/.dbf/.shx/.prj)</li><li>• GeoJSON (.json), KML (.kml)</li><li>• ~90 supported by OGR</li></ul>
Raster	<ul style="list-style-type: none"><li>• Continuous, “gridded” data with embedded coordinates</li><li>• Elevation, satellite images, ground cover</li></ul>	<ul style="list-style-type: none"><li>• GeoTIFF (.TIF or .TIFF)</li><li>• Image (.img)</li><li>• &gt;200 supported by GDAL</li></ul>
Data Attributes	<ul style="list-style-type: none"><li>• Any attribute tied to a location</li><li>• Example: Census data by county</li></ul>	<ul style="list-style-type: none"><li>• CSV (.csv)</li><li>• Database table</li></ul>

# Coordinate Reference Systems

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- ◆ Coordinate Reference Systems (CRS) tie coordinates to real world places
  - Based on a Datum (geographic measurements of Earth and assumptions)
- ◆ Golden rule: know thy data!
  - Combining datasets
  - Knowing what tools expect
- ◆ Examples of coordinate reference systems:
  - WGS 84: US-centric, used for GeoJSON and most web data
  - Others: NAD 83, ITRF



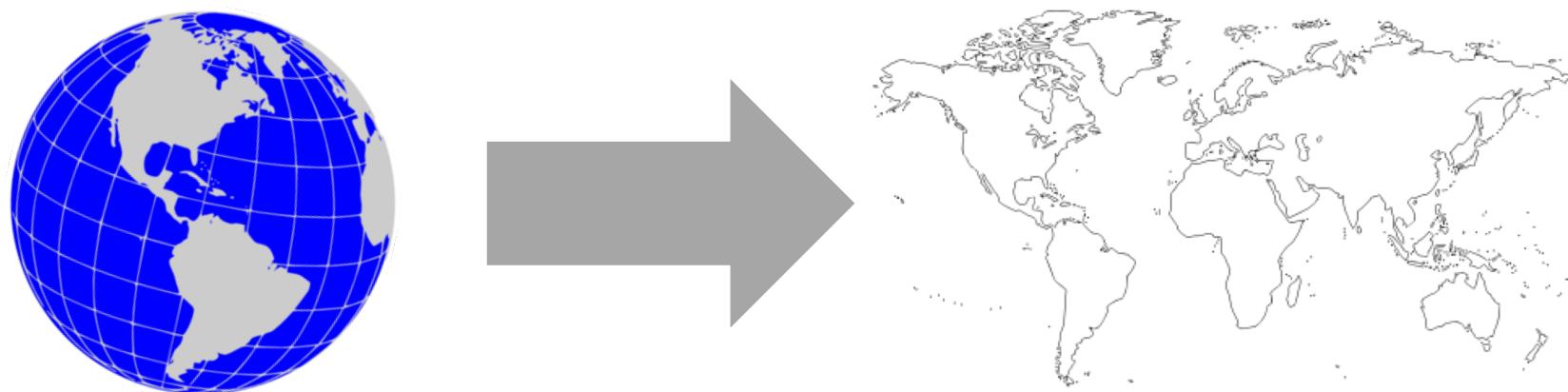
Source:

- Longitude and Latitude (left): By Mike1024 - Based on en:File:EarthTangentialPlane.png by en:User:Raffyl99 (public domain), Public Domain, <https://commons.wikimedia.org/w/index.php?curid=9510652>

# Projections: Translating 3D into 2D

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- ◆ A projection translates 3D coordinates into a 2D representation
  - All projections add an element of distortion
- ◆ Different projections preserve/distort different aspects of the geographic features
- ◆ Common projection: Spherical (or “Web”) Mercator
  - Used by most web tile providers



Source:

- Projected map: molumen on the Open Clip Art Library, CC0, via Wikimedia Commons

## Python Geospatial Packages

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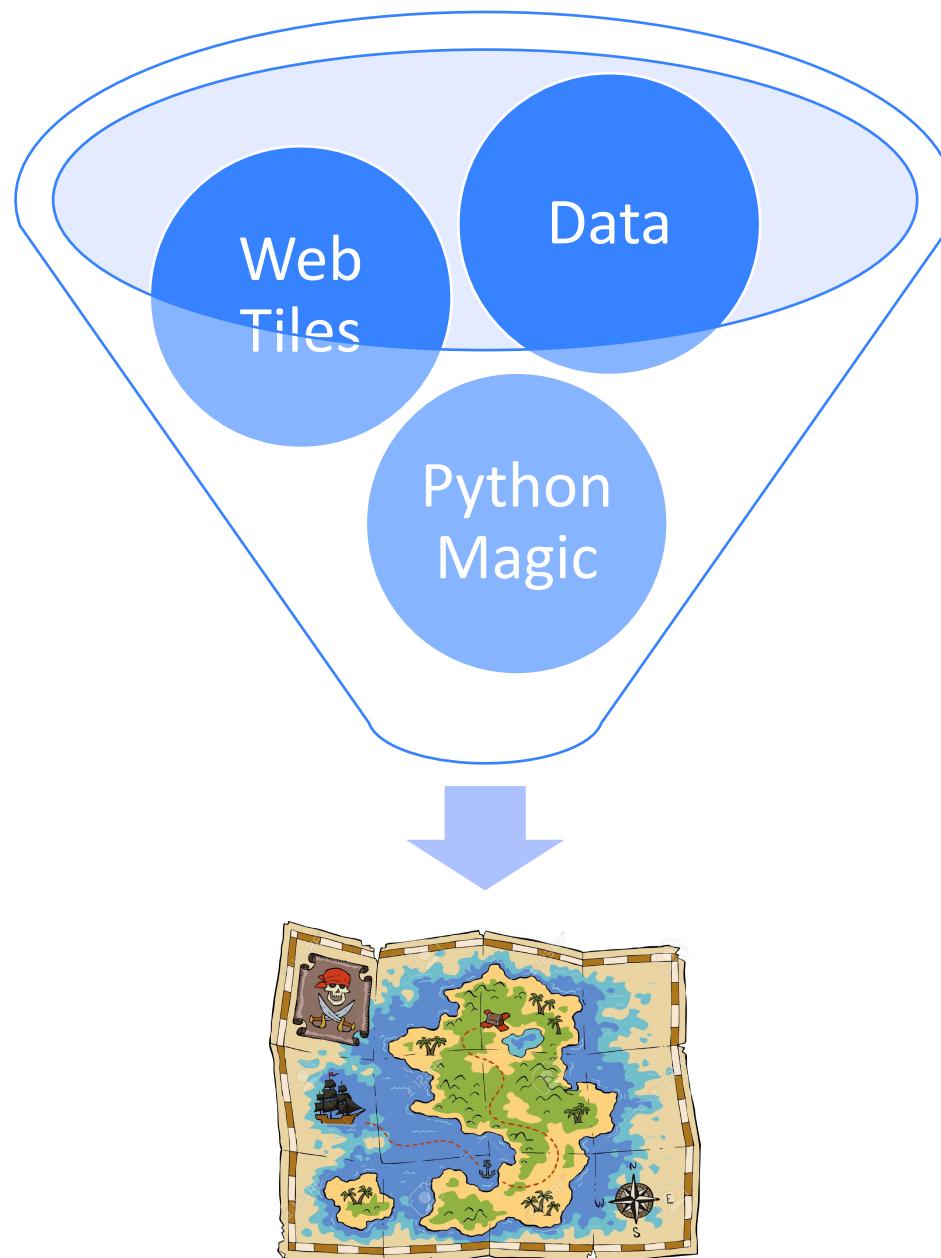


- ◆ **General:** GeoPandas
- ◆ **Supporting Packages:**
  - Fiona (vector I/O), Rasterio (raster I/O)
  - pyproj (CRS/projection transformations)
  - Shapely (implements GEOS geospatial functions)
- ◆ **Visualizations:**
  - folium (leaflet.js)
  - matplotlib
  - contextily (web tiles)
- ◆ **Geocoding:** geoPY



## Code Demo Time!

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## APPENDIX A

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### Resources

# Geospatial 'Acronym Soup' Quick Reference

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Acronym	Full Name	Who/What It Is
OGC	<ul style="list-style-type: none"> <li>• Open Geospatial Consortium</li> </ul>	<ul style="list-style-type: none"> <li>• Sets standards and protocols for the industry</li> </ul>
OSGeo	<ul style="list-style-type: none"> <li>• Open Source Geospatial Foundation</li> </ul>	<ul style="list-style-type: none"> <li>• Finances and maintains many open source geospatial projects</li> </ul>
GDAL	<ul style="list-style-type: none"> <li>• Geospatial Data Abstraction Library</li> </ul>	<ul style="list-style-type: none"> <li>• C++ library under OSGeo to handle file I/O for raster formats</li> </ul>
OGR	<ul style="list-style-type: none"> <li>• Open GIS Reference Implementation</li> </ul>	<ul style="list-style-type: none"> <li>• Part of GDAL; handles file I/O for vector formats</li> </ul>
GEOS	<ul style="list-style-type: none"> <li>• Geometry Engine – Open Source</li> </ul>	<ul style="list-style-type: none"> <li>• C++ library under OSGeo to implement geospatial functions</li> </ul>
PROJ	<ul style="list-style-type: none"> <li>• PROJ</li> </ul>	<ul style="list-style-type: none"> <li>• Software under OSGeo to make CRS and projection conversions</li> </ul>
EPSG	<ul style="list-style-type: none"> <li>• European Petroleum Survey Group (now synonymous with registry itself)</li> </ul>	<ul style="list-style-type: none"> <li>• Registry (and codes for) datums, spatial reference systems, and transformations</li> </ul>

# Resources

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- ◆ Eastern Search & Survey on Facebook:
  - <https://www.facebook.com/Eastern-Search-Survey-109413857123876>
- ◆ Eastern Search & Survey free interactive Google map:
  - [https://www.google.com/maps/d/u/0/viewer?mid=1dMRBuqZSxv1ULdiPi76\\_ZQCiHB0OkW7NV&ll=40.306301090519035%2C-73.53378835388357&z=7](https://www.google.com/maps/d/u/0/viewer?mid=1dMRBuqZSxv1ULdiPi76_ZQCiHB0OkW7NV&ll=40.306301090519035%2C-73.53378835388357&z=7)
- ◆ GitHub project repository:
  - NY Python
- ◆ Documentation:
  - GeoPandas: <https://geopandas.org/index.html#>
  - Shapely: <https://shapely.readthedocs.io/en/stable/manual.html>
  - folium: <https://python-visualization.github.io/folium/>
- ◆ Codes for most commonly used CRSs and projections:
  - [www.spatialreference.org](http://www.spatialreference.org)
- ◆ Get help via the GIS stack exchange
  - <https://gis.stackexchange.com/>
- ◆ Learn more with the Kaggle's free Geospatial Analysis course:
  - <https://www.kaggle.com/learn/geospatial-analysis>