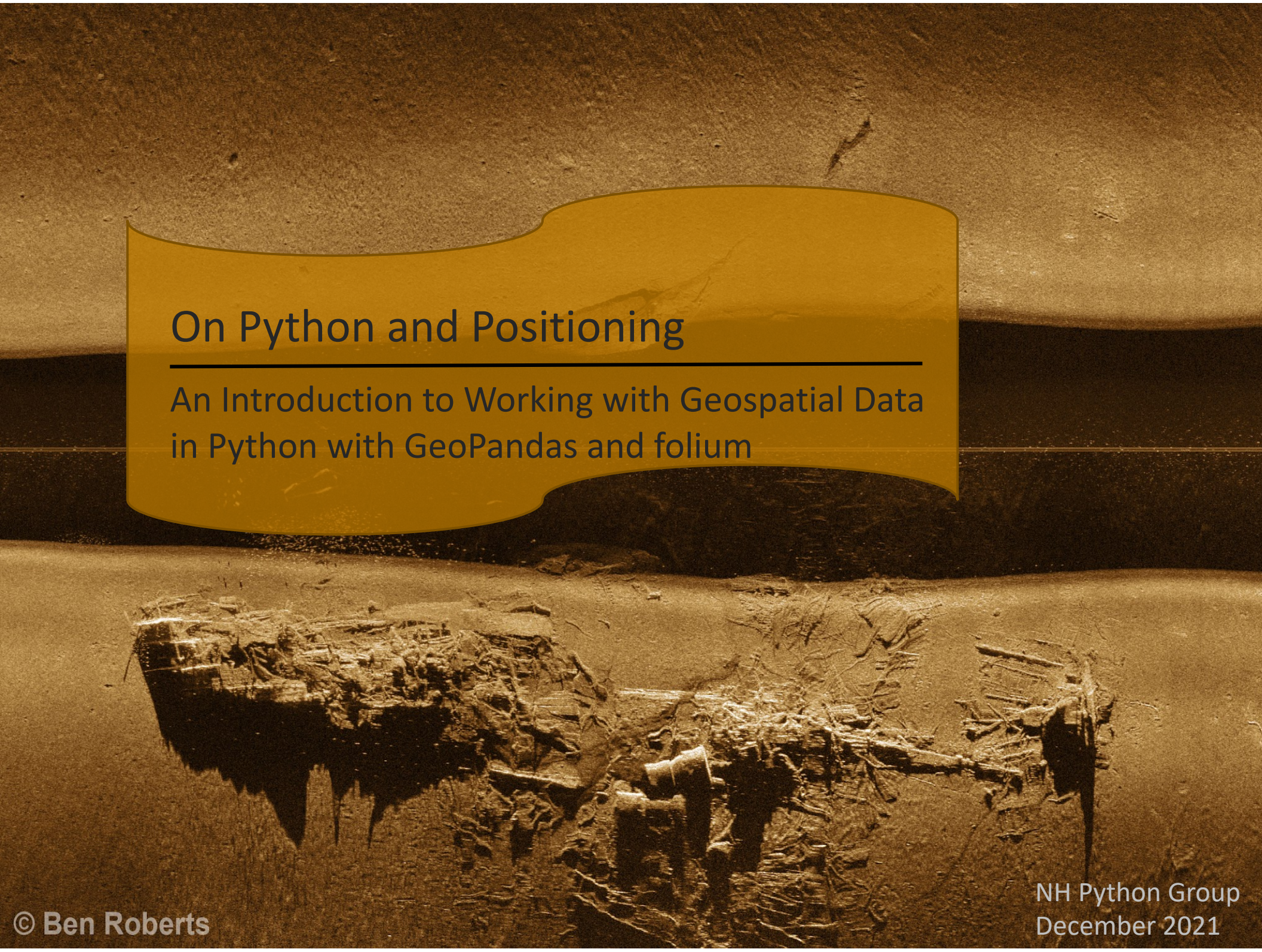
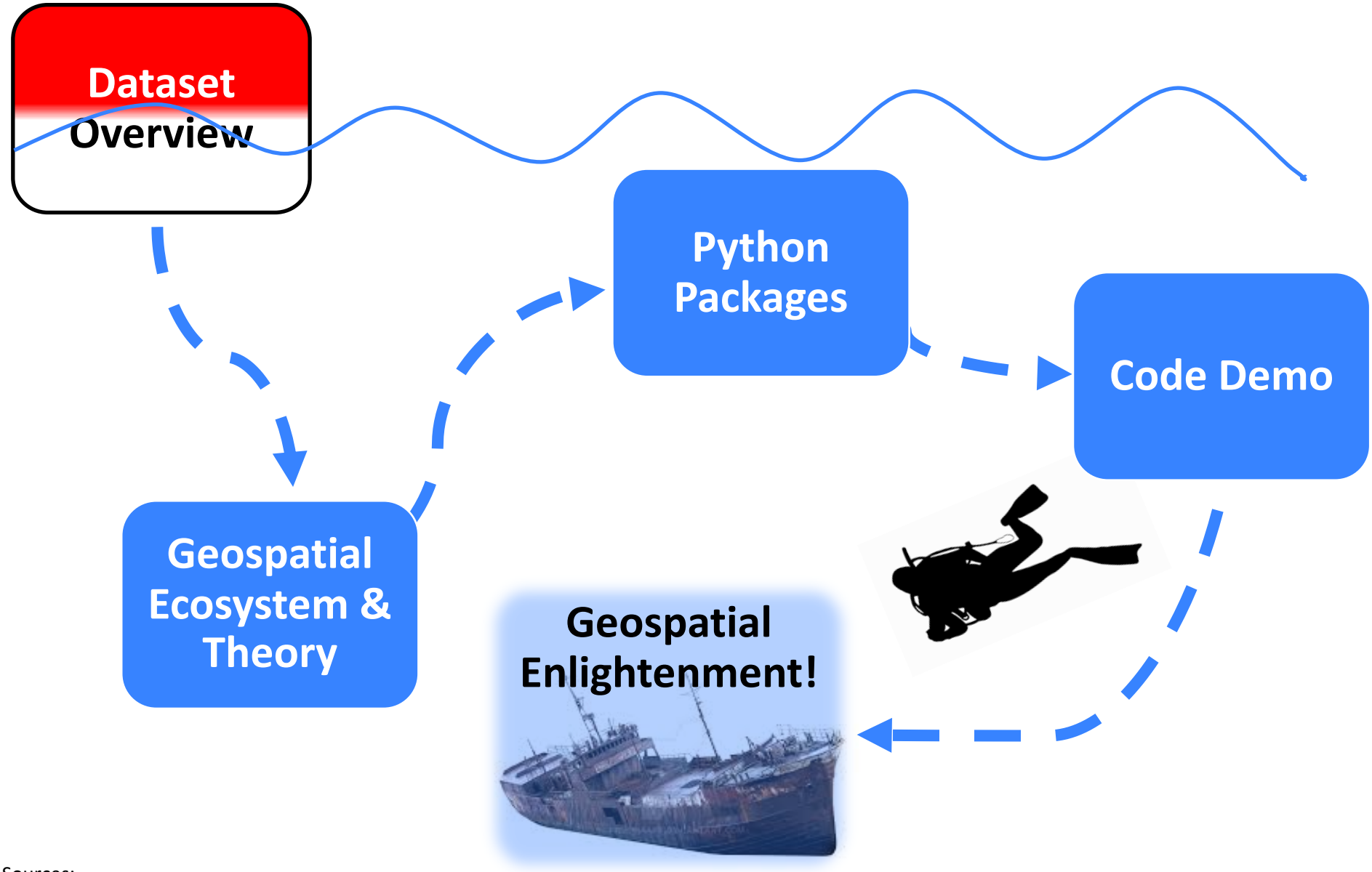

On Python and Positioning
An Introduction to Working with Geospatial Data in Python with GeoPandas and folium
NH Python Group
December 2021
© Ben Roberts

This Evening's Quest



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

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[1]

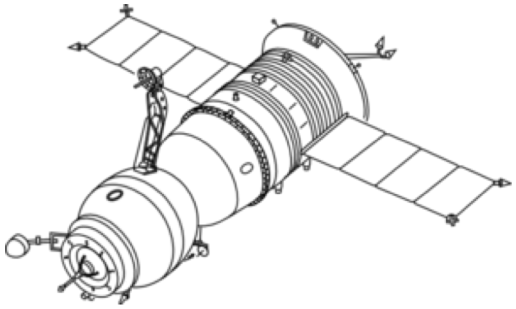
Industry Protocols

- Open Geospatial Consortium (OGC)

GIS Software

- **OSGeo Projects:** GDAL/OGR, GEOS, PROJ
- **Desktop Apps:** QGIS, ArcGIS, others
- Python packages

Data Collection

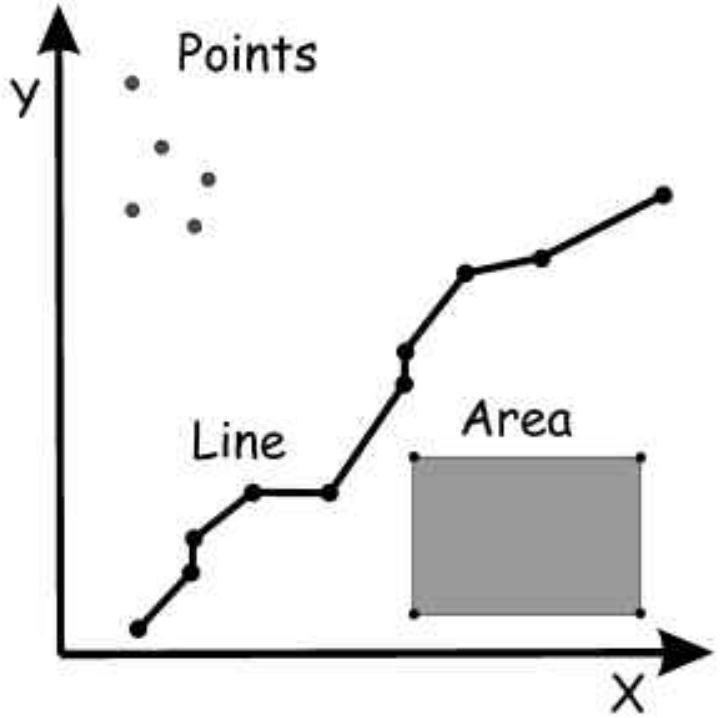


Data Storage

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

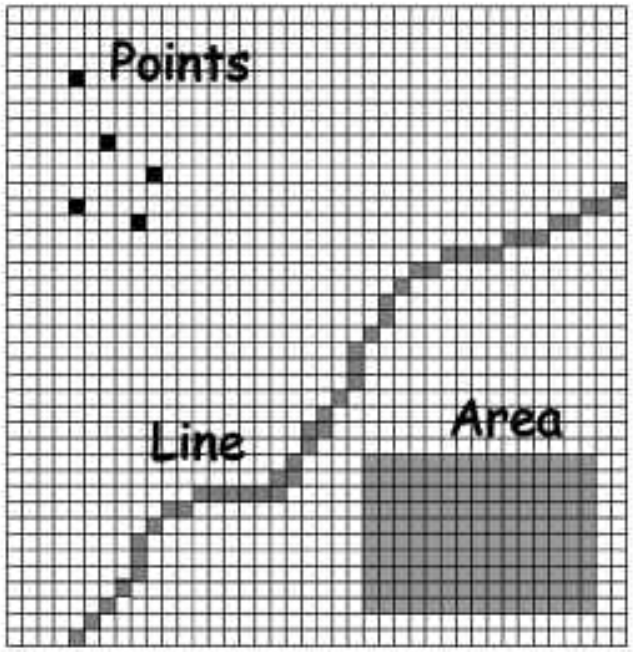
Overview of Geospatial Data Models

Vector Data



- Discrete geometries
- Points, lines, polygons described by coordinates

Raster Data



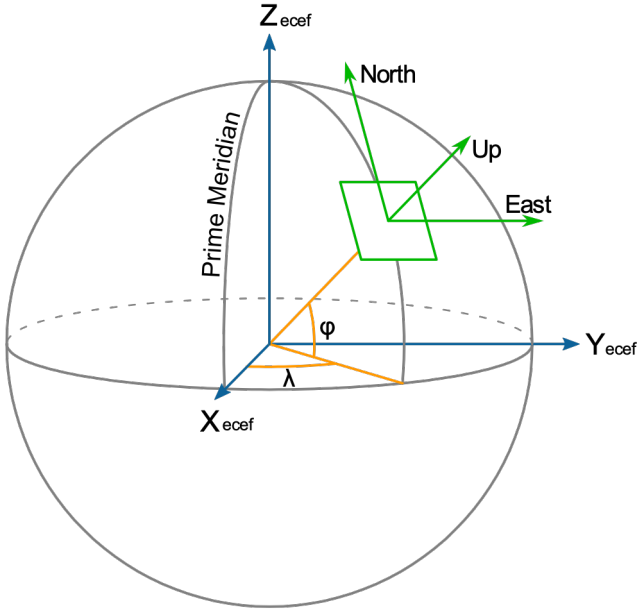
- Continuous, “gridded” data with embedded coordinates
- Elevation, satellite images, ground cover

Geospatial Data Models

	File Format Examples
Vector Data	• Shapefile (.shp/.dbf/.shx/.prj) • GeoJSON (.json), KML (.kml) • ~90 supported by OGR
Raster Data	• GeoTIFF (.TIF or .TIFF) • Image (.img) • >200 supported by GDAL
Data Attribute Tables	• Any attribute tied to a location or geometry • CSV (.csv) • Database table

Coordinate Reference Systems

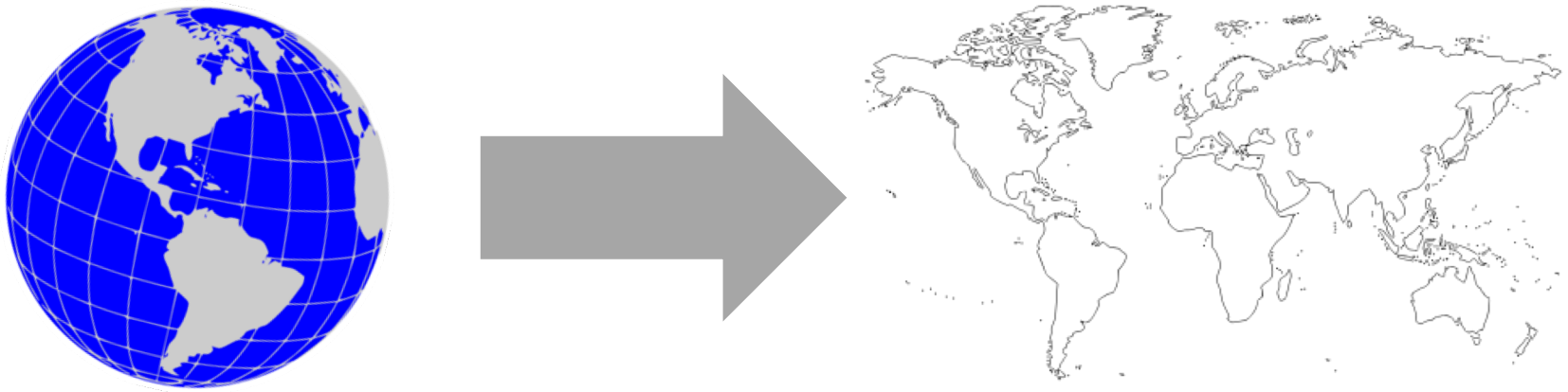
- Coordinate Reference Systems (CRS) tie coordinates to real world places
  - Based on a Datum (geographic measurements of Earth and assumptions)
- Golden rule: know thy data!
  - Combining datasets
  - Knowing what tools expect
- Examples of coordinate reference systems:
  - WGS 84: US-centric, used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

- 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

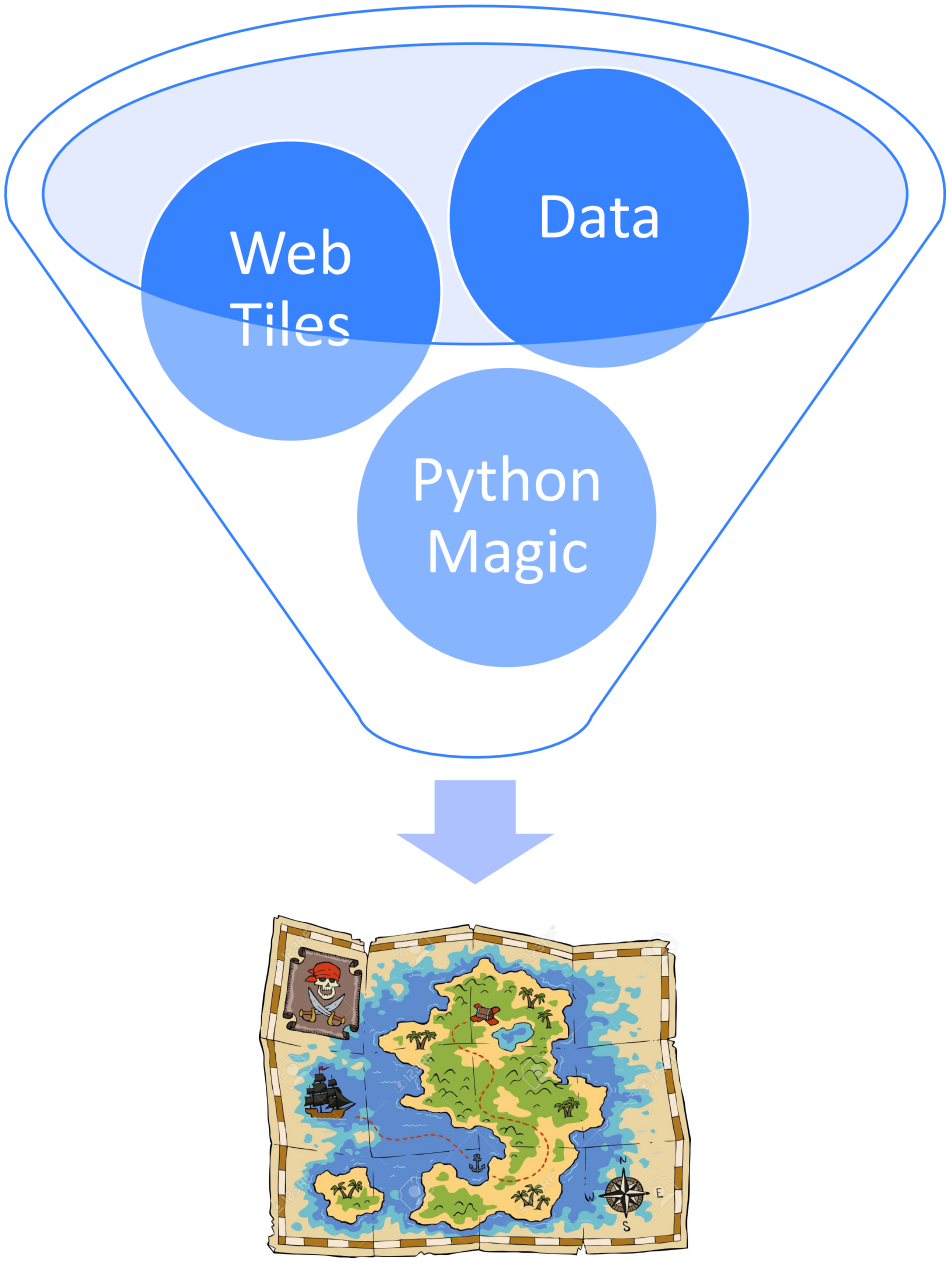


Source:
- Projected map: molumen on the Open Clip Art Library, CC0, via Wikimedia Commons

Python Geospatial Packages

- **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!



APPENDIX A

Resources

Geospatial 'Acronym Soup' Quick Reference

Acronym	Full Name	Who/What It Is
OGC	• Open Geospatial Consortium	• Sets standards and protocols for the industry
OSGeo	• Open Source Geospatial Foundation	• Finances and maintains many open source geospatial projects
GDAL	• Geospatial Data Abstraction Library	• C++ library under OSGeo to handle file I/O for raster formats
OGR	• Open GIS Reference Implementation	• Part of GDAL; handles file I/O for vector formats
GEOS	• Geometry Engine – Open Source	• C++ library under OSGeo to implement geospatial functions
PROJ	• PROJ	• Software under OSGeo to make CRS and projection conversions
EPSG	• European Petroleum Survey Group (now synonymous with registry itself)	• Registry (and codes for) datums, spatial reference systems, and transformations

Resources

- 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=1dMRBuqZSxv1ULdiPi76ZQCiHB0OkW7NV&ll=40.306301090519035%2C-73.533788353883 57&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 and https://epsg.io/
- Get help via the GIS stack exchange
  - https://gis.stackexchange.com/