AAE 875 – Fundamentals of Object Oriented Programming and Data Analytics

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Week 6 - Summer 2019

Logistics – deadline extensions

- zyLabs 11 – 13 are due tomorrow (8/8) at 11:59 pm
- FinalProgram is due on Monday (8/12) at 11:59 pm

Logistics – final exam

- Monday (8/12) between 10-12 pm
- Location: CS 1370 lab
- **How to prepare**: all material in zyBooks, Lectures, Labs (with Adam), guest speaker (Anton B.)
- Level of difficulty?

GIS

- What is GIS? Software
- GIS with Python
- The coordinate system
- Geometric objects/ Spatial data
- Geocoding

What is GIS?

- A geographic information system (GIS) designed to capture, store, manipulate, analyze, manage, and present all types of geographical **data**

- **Data** = spatial data (location on earth) + attribute data (additional information)

- Schools example:
  - Spatial data = actual location of the schools
  - Attribute data = school name, level of education, student capacity etc.

GIS Software

- Plenty of options…
- At UW: ArcGIS, QGIS
- More info here: https://researchguides.library.wisc.edu/c.php?g=178144&p=1169833

GIS with Python

- Can do GIS-related tasks w/o third party software (e.g. ArcGIS)

- Benefits of using Python:
  - Open-source
  - Deeper understanding of geographical concepts
  - Python supports all data formats
  - etc.

Installing Python GIS on Windows/Mac

- Best to use Anaconda
- Install GIS related packages using conda and pip
- Step by step installation instructions here: https://automating-gis-processes.github.io/CSC18/course-info/Installing_Anacondas_GIS.html
- Make sure to follow specific order of packages (!) it will not work otherwise.

GIS with Python

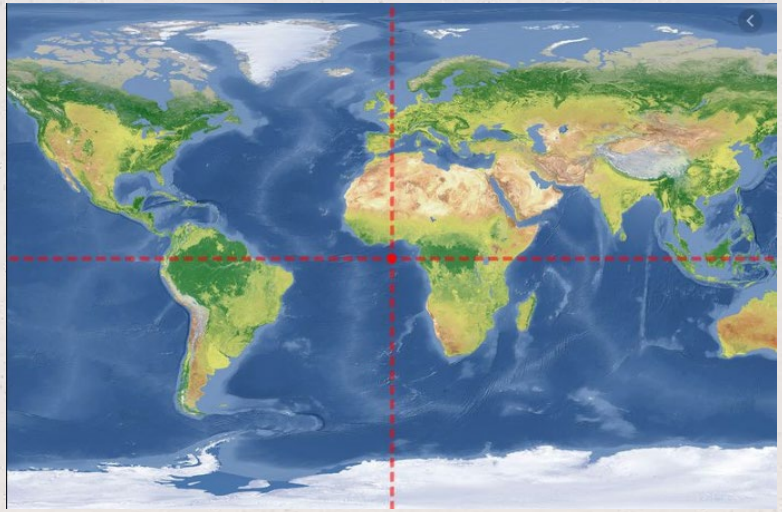
- Useful packages for GIS:
  - GDAL
  - Geopandas
  - Shapely
  - Fiona
  - Pysal
  - Geopy
  - GeoViews
  - OSMnx
  - Networkx
  - Etc.

- For description check here: https://automating-gis-processes.github.io/CSC18/lessons/L1/Intro-Python-GIS.html

The coordinate system

- A system that uses coordinates (x, y) to uniquely determine the position of the points or other geometric objects on a manifold (such as Euclidean space)

- The (0, 0) coordinate, i.e. 0 degrees latitude and 0 degrees longitude



Source: https://www.thoughtco.com/prime-meridian-and-the-equator-intersect-4070819

The point where **the equator** (0 degree latitude) and **the prime meridian** (0 degrees longitude) intersect.

Falls in the middle of a less known body of water (an area in the Gulf of Guinea)

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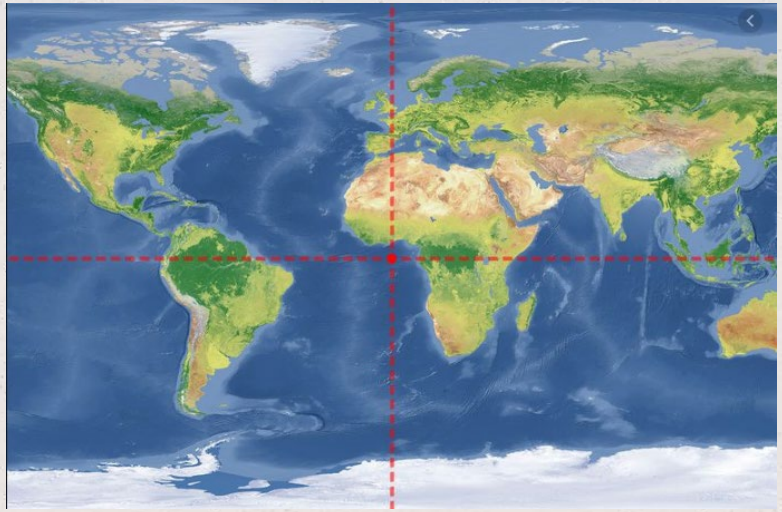

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Source: https://www.nsgic.org/null-island

The null island

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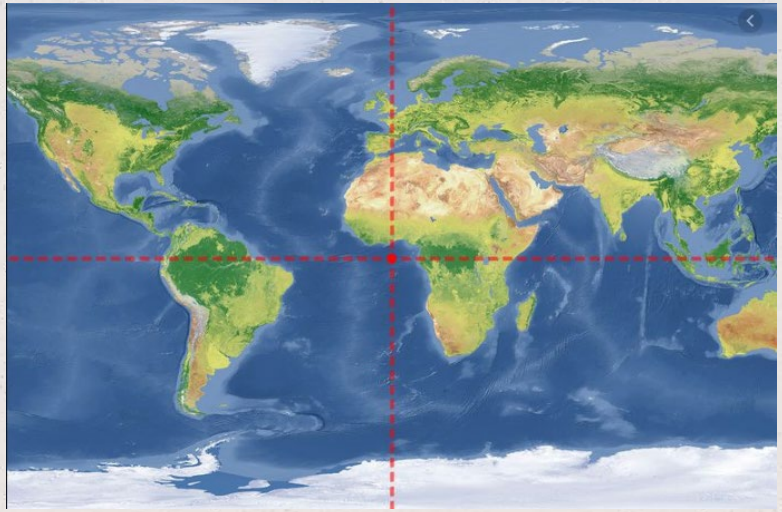

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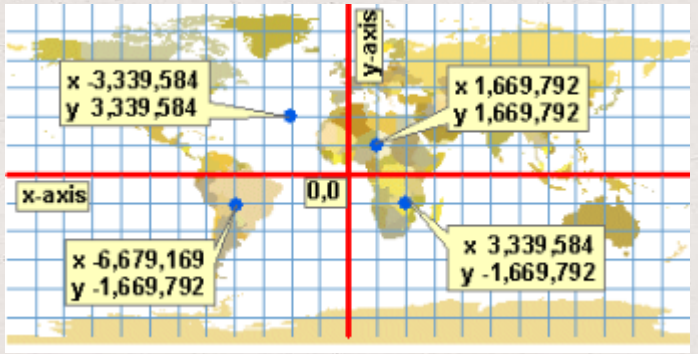

Source: http://www.geography.hunter.cuny.edu/~jochen/GTECH361/lectures/lecture04/concepts/06%20-%20Projected%20coordinate%20systems.html

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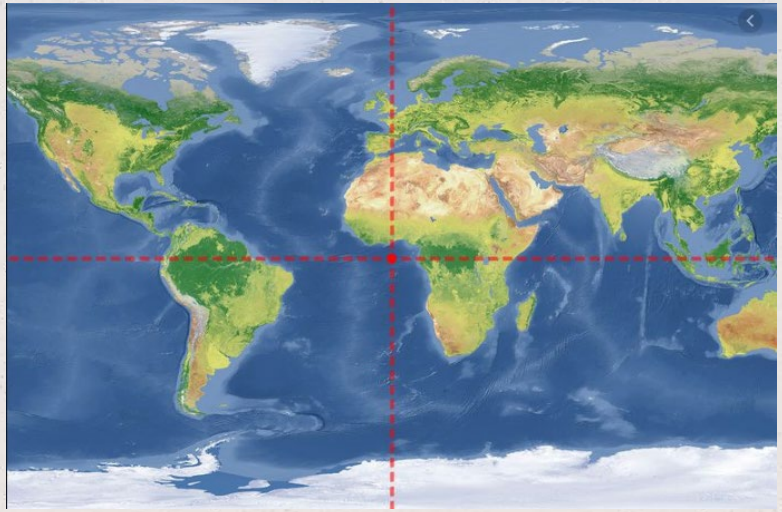

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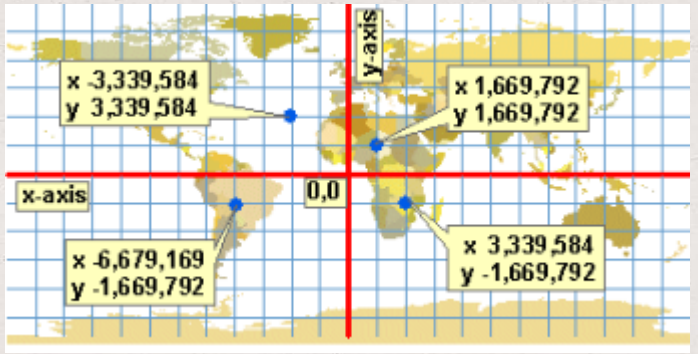

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Geometric objects and Shapely module

- The **Shapely module** in Python can be sed to create and manipulate geometric objects
- Main geometric objects:
  - Point
  - LineString
  - Polygon

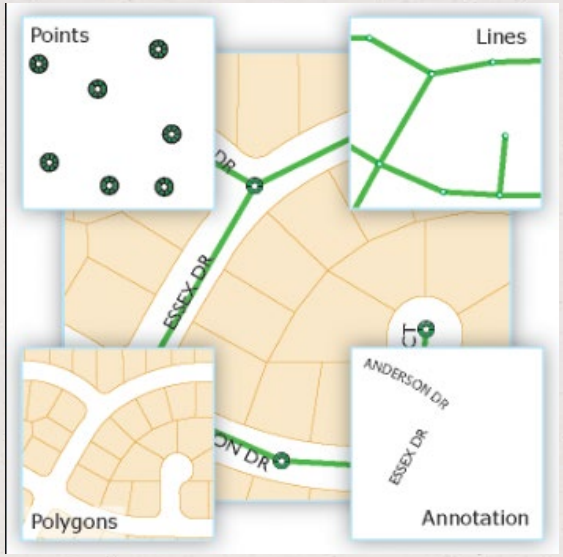
Geometric objects and Shapely module

- **Points** represent a single point in space:
  - 2D (lat, lon)
  - 3D (lat, lon, alt)

- **LineString** represent a sequence of points joined together to form a line
  - A list of at least two coordinate tuples

- **Polygon** represents a filled area
  - A list of at least three coordinate tuples

- Let's see example in Python. Check it here.



Source:
https://desktop.arcgis.com/en/arcmap/latest/manage-data/geodatabases/feature-class-basics.htm

Spatial data and Geopandas module

- Read and write spatial data (shapefiles)
- Create geometries into GeoDataFrame
- Let’s see an example in Python. Check it here.

Geocoding

- Geocoding = convert addresses into coordinate points (and viceversa).
- Geocoding is very easy in Python using the **geopy** library
- **geopy** uses third-party geocoders to locate an address (works with multiple providers)
- Check here for more information on third-party geocoders: https://automating-gis-processes.github.io/CSC18/lessons/L3/geocoding.html

Geocoding

- To use the service of most third-party geocoders you will need to request an API access-key
- However, **Nominatim** is API access key-free for small scale geocoding jobs
- Nominatum is a geocoder based on **OpenStreetMap** data
- We will work on a geocoding exercise by using Nominatum services. More precisely we will retrieve OpenStreetMap data using an address and the **OSMnx module**.

Geocoding

- **OpenStreetMap** data is a collaborative project to create free editable map of the world containing plenty of information on streets, buildings, services, etc.

- The **OSMnx module** can be used to retrieve, construct, analyze, and visualize street networks from OpenStreetMap

- Let’s look at this example.

References

- The Coordinate System:

https://en.wikipedia.org/wiki/Coordinate_system

- GIS with Python:

https://automating-gis-processes.github.io/CSC18/course-info/course-info.html