

[AAA] Advanced Analytics and Applications

Summer Semester 2021

Problem Set 4 – Spatial Analytics

1. Multiple Choice Questions

- a. Which of the following elements are not basic elements of visual hierarchy?
 - i. Color
 - ii. Arcs
 - iii. Icons
 - iv. 3D Objects
- b. True or False? Coordinate Reference Systems map information located on a sphere to 2D projection while optimizing the shape, distance, and area together.
 - i. True
 - ii. False

2. Introduction to GeoPandas

- a. Install GeoPandas and H3 for Python.
- b. Read the docs of GeoPandas
https://geopandas.org/docs/user_guide/data_structures.html
 - i. Which geometry objects are available?
 - ii. Which attributes of these geometry objects are important for us?
 - iii. Which fundamental methods are available for GeoPanda DataFrames?
- c. Plotting with GeoPandas:
Load the following **World** GeoDataFrame and plot it.

```
geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
```

- d. Plot only the centroids of each country.
- e. Reread the **World** dataframe but filter for countries from Africa (while reading the file using a **mask**).
 - i. Write the resulting file into a shape file and a GeoJSON file.
- f. Reread the **World** dataframe without using a mask.
 - i. Select only countries in Europe using **coordinate based indexing**. (Latitude: 0-10, Lng: 40:60)

3. Visualizing Data with GeoPandas

- a. Load the following data:

```
# Load spatial toy data
world =
geopandas.read_file(geopandas.datasets.get_path('naturalearth_lowres'))
cities =
geopandas.read_file(geopandas.datasets.get_path('naturalearth_cities'))
```
- b. Plot the worldmap and color the country color based on GDP.
 - i. Use a choropleth map
 - ii. Add a legend
 - iii. Change the default coloring
 - iv. Plot missing data and color it in lightgrey
- c. Plot first the country boundaries (layer 1) and on top of it, plot the cities (layer 2)

4. Coordinate Reference Systems with GeoPandas

- a. How can we add coordinate reference systems to GeoPandas dataframes?
- b. How can we change the coordinate reference system of an existing GeoPandas dataframe?

5. Geometric Manipulations

- a. Create geometric toy data as follows:

```
import geopandas
from geopandas import GeoSeries
from shapely.geometry import Polygon
p1 = Polygon([(0, 0), (1, 0), (1, 1)])
p2 = Polygon([(2, 0), (3, 0), (3, 1), (2, 1)])
g = GeoSeries([p1, p2])
g.plot()
```

- b. Calculate the area of the respective geometries using GeoPandas functions.
- c. Calculate a buffer of 0.5 for the dataframe g.

6. Overlay Operator

- a. Create the following geometric toy data as follows:

```
from shapely.geometry import Polygon

polys1 = geopandas.GeoSeries([Polygon([(0,0), (2,0), (2,2), (0,2)]),
                               Polygon([(2,2), (4,2), (4,4), (2,4)])])

polys2 = geopandas.GeoSeries([Polygon([(1,1), (3,1), (3,3), (1,3)]),
                               Polygon([(3,3), (5,3), (5,5), (3,5)])])

df1 = geopandas.GeoDataFrame({'geometry': polys1, 'df1':[1,2]})
df2 = geopandas.GeoDataFrame({'geometry': polys2, 'df2':[1,2]})

df1
```

- b. Plot both dataframes in one Figure using different colors.
- c. Calculate and plot the resulting geometries of both DataFrames using
 - i. Intersection
 - ii. Union
 - iii. Symmetric difference
 - iv. Difference

7. Spatial Aggregation:

- a. Read the docs:

https://geopandas.org/docs/user_guide/aggregation_with_dissolve.html

- b. Explain the dissolve operator.
- c. What is the difference between dissolve and sjoin?