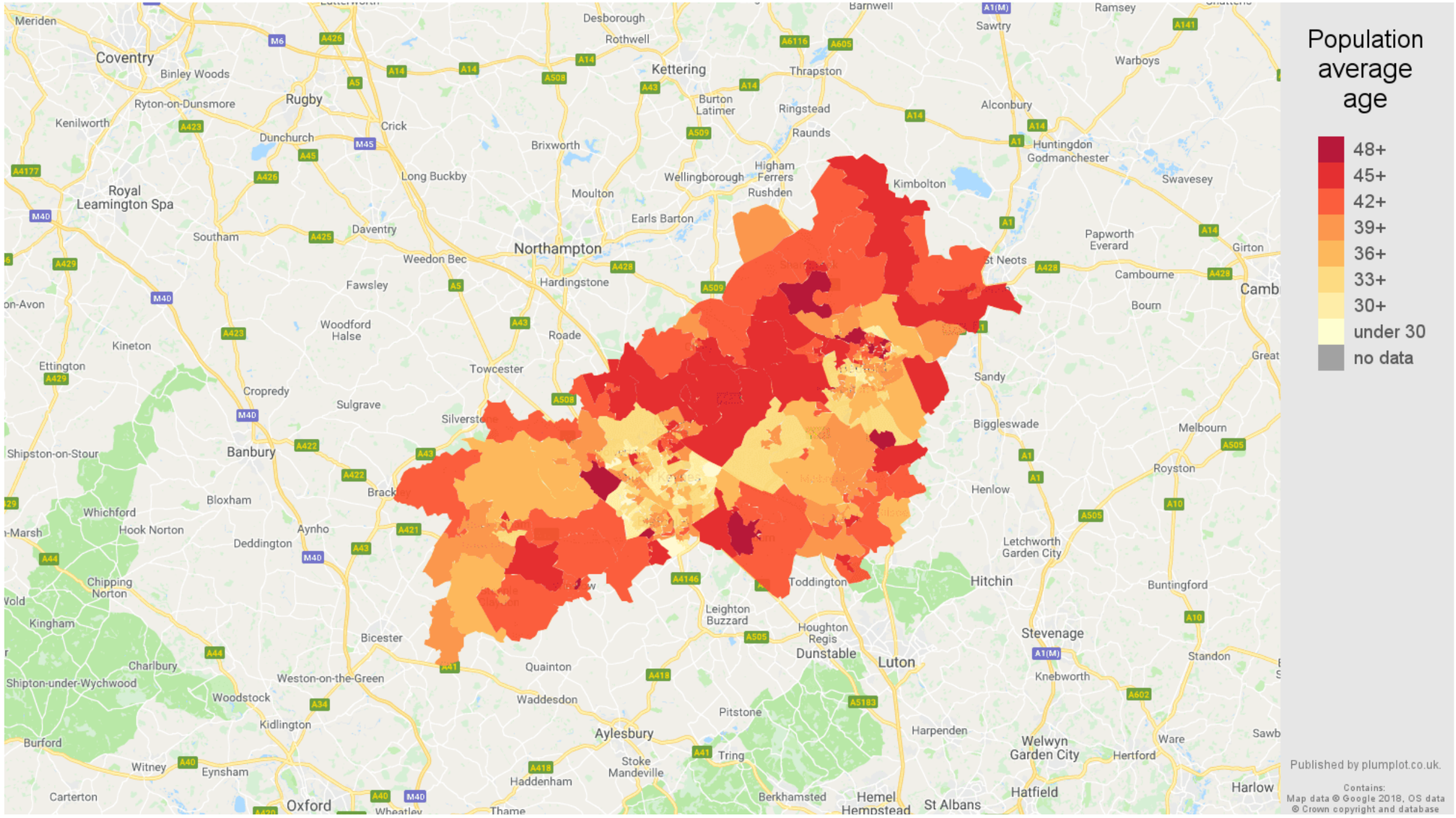
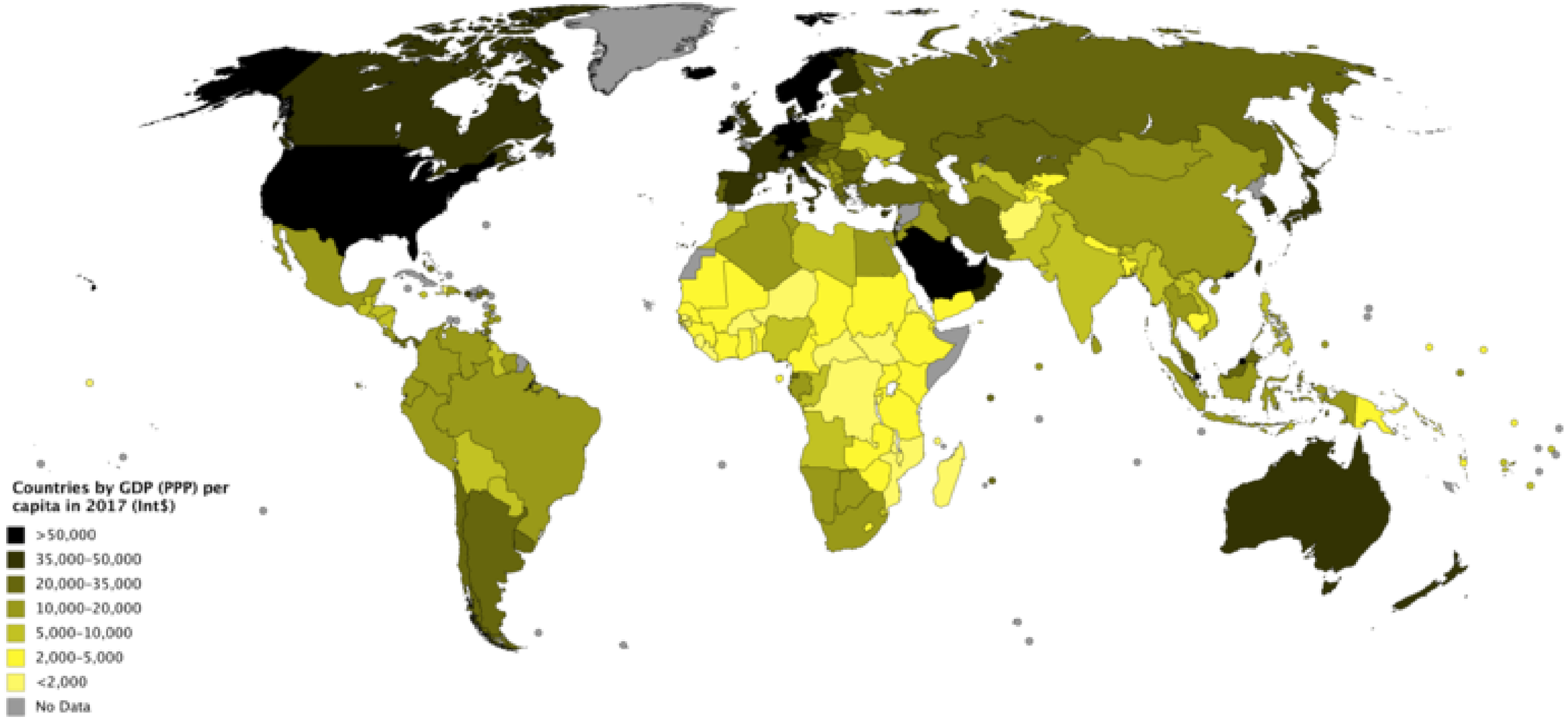
What is a choropleth?

VISUALIZING GEOSPATIAL DATA IN PYTHON

Mary van Valkenburg
Data Science Program Manager,
Nashville Software School

Definition of a choropleth




Countries by GDP (PPP) per capita in 2017 (Int$)
>50,000
35,000–50,000
20,000–35,000
10,000–20,000
5,000–10,000
2,000–5,000
<2,000
No Data

Density

```
schools_in_districts.head(2)
```

```
district  geometry                    name              lat    lng
1         (POLYGON ((-86.77 36.38...  Nashville Prep    36.16 -86.85
1         (POLYGON ((-86.77 36.38...  Rocketship Prep   36.17 -86.79
```

Get counts

```
school_counts = schools_in_districts.groupby(['district']).size()
print(school_counts)
```

```
district
1    30
2    11
3    19
4    18
5    36
6    21
7    13
8    10
9    12
dtype: int64
```

Add counts

```
school_counts_df = school_counts.to_frame()
school_counts_df = school_counts_df.reset_index()
school_counts_df.columns = ['district', 'school_count']
```

```
districts_with_counts = pd.merge(school_districts, school_counts_df,
                                 on = 'district')
districts_with_counts.head(2)
```

```
district geometry              school_count
1        (POLYGON ((-86.77 36.38...  30
3        (POLYGON ((-86.75 36.40...  19
```

Divide counts by areas

```
districts_with_counts['area'] = districts_with_counts.geometry.area
```

```
districts_with_counts['school_density'] = districts_with_counts.apply(
    lambda row: row.school_count/row.area, axis = 1)

districts_with_counts.head(2)
```

```
district geometry             school_count   area     school_density
1        (POLYGON ((-86.77 36.38...    30     0.036641    818.745403
3        (POLYGON ((-86.75 36.40...    19     0.014205    1337.594495
```

Let's Practice!

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Choropleths with geopandas

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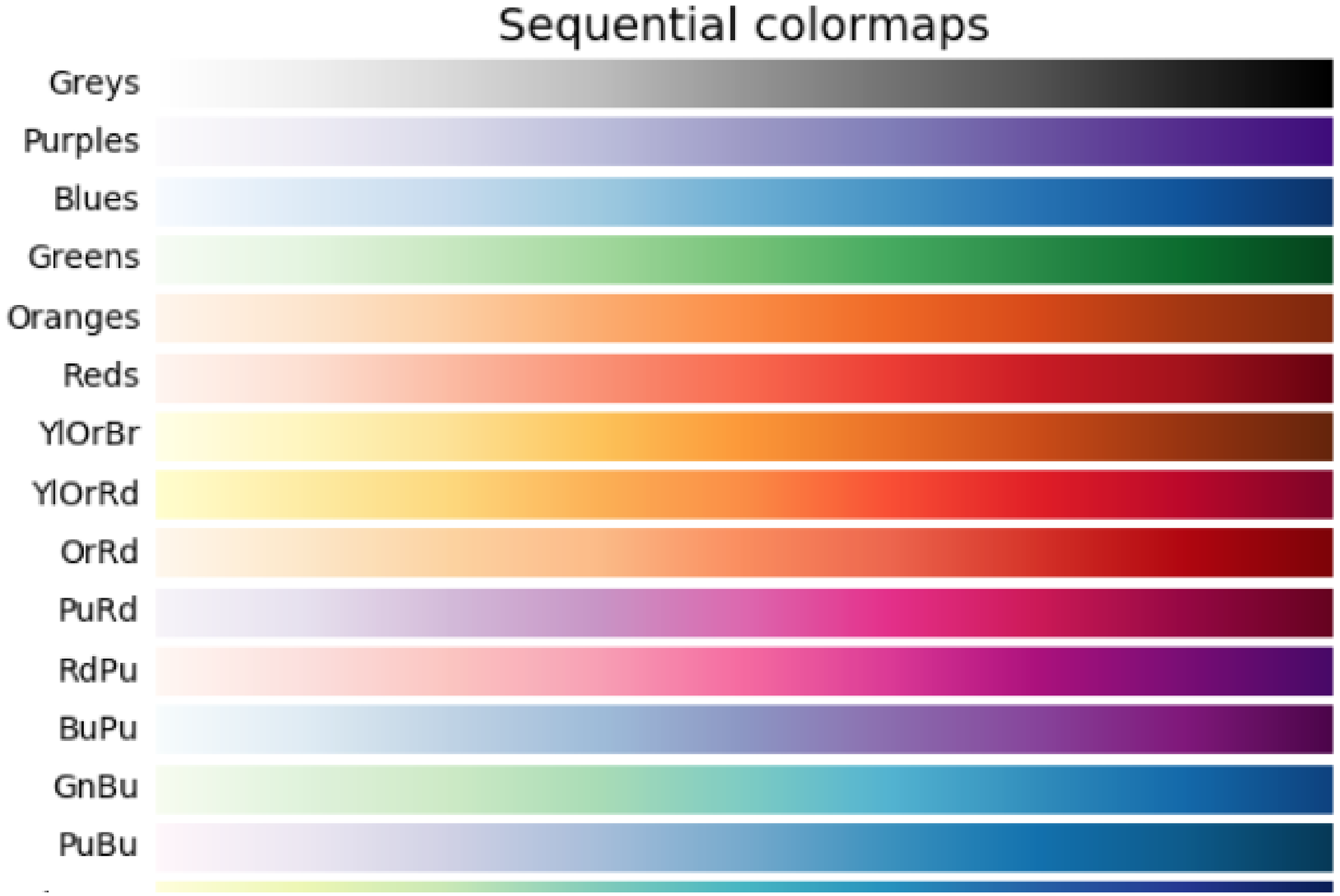
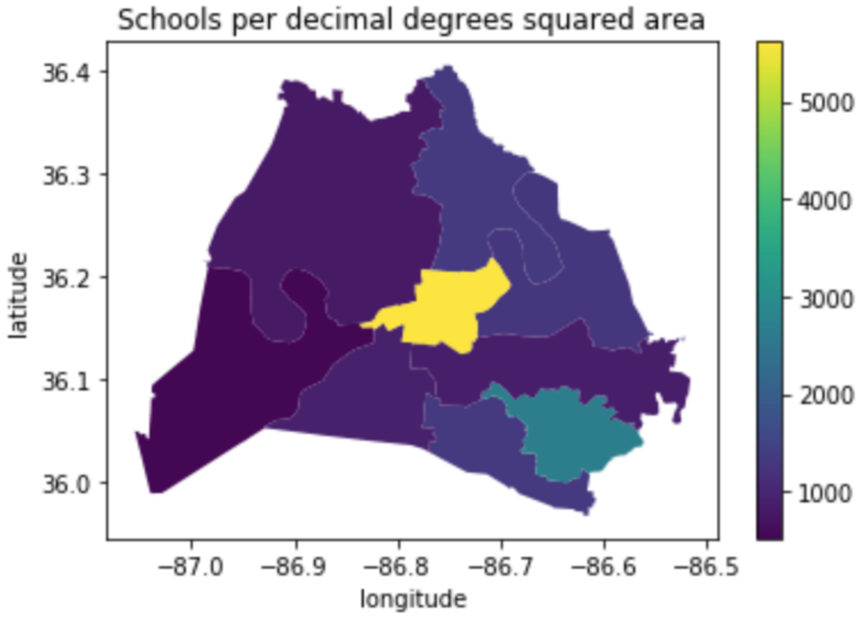

Sequential colormaps
Greys
Purples
Blues
Greens
Oranges
Reds
YlOrBr
YlOrRd
OrRd
PuRd
RdPu
BuPu
GnBu
PuBu

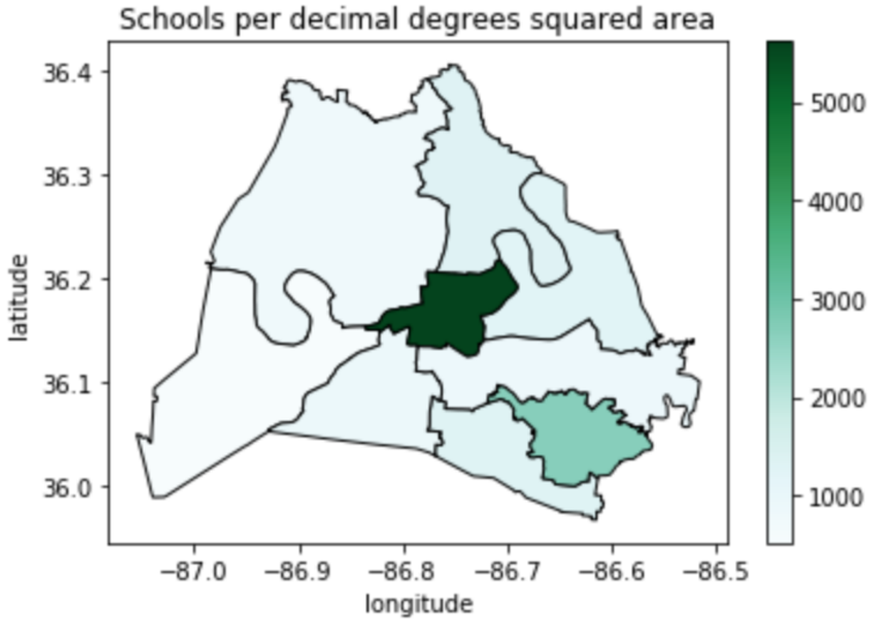
Choropleth with GeoDataFrame.plot()

```
districts_with_counts.plot(column = 'school_density', legend = True)
plt.title('Schools per decimal degrees squared area')
plt.xlabel('longitude')
plt.ylabel('latitude');
```



Choropleth with GeoDataFrame.plot()

```
districts_with_counts.plot(column = 'school_density', cmap = 'BuGn', edgecolor = 'black', legend =
plt.title('Schools per decimal degrees squared area')
plt.xlabel('longitude')
plt.ylabel('latitude');
```



Area in Kilometers Squared

```
# starting CRS
print(school_districts.crs)
```

```
{'init': 'epsg:4326'}
```

```
# convert to EPSG 3857
school_districts = school_districts.to_crs(epsg = 3857)
print(school_districts.crs)
```

```
{'init': 'epsg:3857', 'no_defs': True}
```

Area in Kilometers Squared

```
# define a variable for m^2 to km^2
sqm_to_sqkm = 10**6

school_districts['area'] = school_districts.geometry.area / sqm_to_sqkm
school_districts.head(2)
```

```
district    geometry                                area
1          (POLYGON ((-965.055 4353528.766...    563.134380
3          (POLYGON ((-965.823 4356392.677...    218.369949
```

```
# change crs back to 4326
school_districts = school_districts.to_crs(epsg = 4326)
print(school_districts.crs)
```

```
{'init': 'epsg:4326', 'no_defs': True}
```

```
print(school_districts.head(2))
```

```
district      geometry                          area
1             (POLYGON ((-86.771 36.383...   563.134380
3             (POLYGON ((-86.753 36.404...   218.369949
```

```
# spatial join to get districts that contain schools
schools_in_districts = gpd.sjoin(school_districts, schools_geo, op = 'contains')
```

```
# aggregate to get counts
school_counts = schools_in_districts.groupby(['district']).size()
```

```
# convert school_counts to a df
school_counts_df = school_counts.to_frame()
school_counts_df = school_counts_df.reset_index(level=0)
school_counts_df.columns = ['district', 'school_count']
```

```
# merge
districts_with_counts = pd.merge(school_districts,
                                 school_counts_df, on = 'district')
```

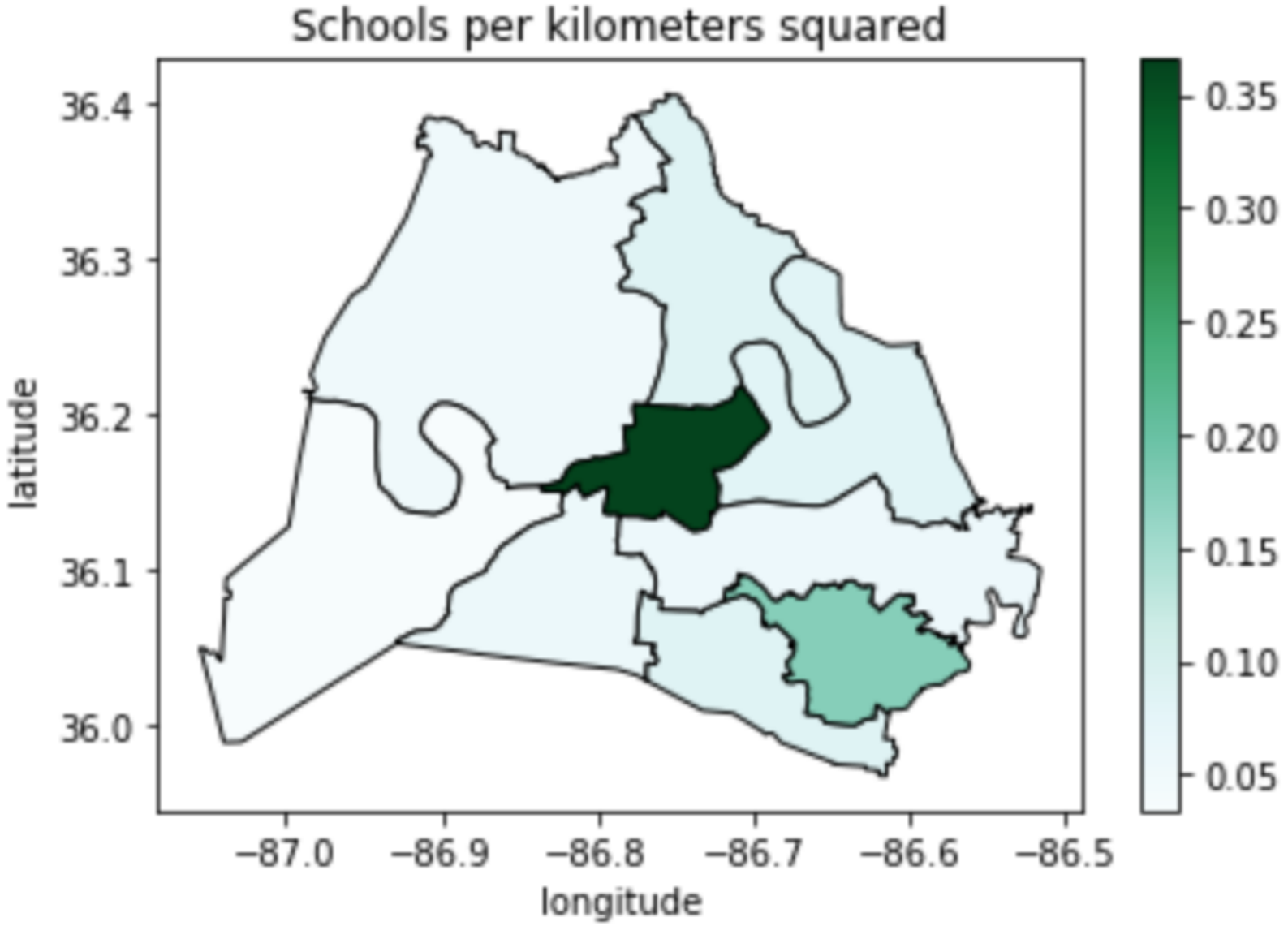
```
districts_with_counts.head(1)
```

```
district  geometry                        area        school_count
1         (POLYGON ((-86.771 36.383..     563.134380    30
```

Calculating school density

```
# create school_density
districts_with_counts['school_density'] = districts_with_counts.apply(
    lambda row: row.school_count/row.area, axis = 1)
```

```
# plot it
districts_with_counts.plot(column = 'school_density', cmap = 'BuGn',
                           edgecolor = 'black', legend = True)
plt.title('Schools per kilometers squared')
plt.xlabel('longitude')
plt.ylabel('latitude')
plt.show();
```


Schools per kilometers squared
36.4
36.3
36.2
36.1
36.0
latitude
−87.0
−86.9
−86.8
−86.7
−86.6
−86.5
longitude
0.35
0.30
0.25
0.20
0.15
0.10
0.05

Let's practice!

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Choropleths with folium

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folium.Map choropleth

```
# Construct a map object for Nashville
nashville = [36.1636,-86.7823]
m = folium.Map(location=nashville, zoom_start=10)

# Create a choropleth
m.choropleth(...)
```

Arguments of the folium choropleth

- `geo_data` - the source data for the polygons (geojson file or a GeoDataFrame)
- `name` - the name of the geometry column (or geojson property) for the polygons
- `data` - the source DataFrame or Series for the normalized data
- `columns` - a list of columns: one that corresponds to the polygons and one that has the value to plot

Additional arguments of the folium choropleth

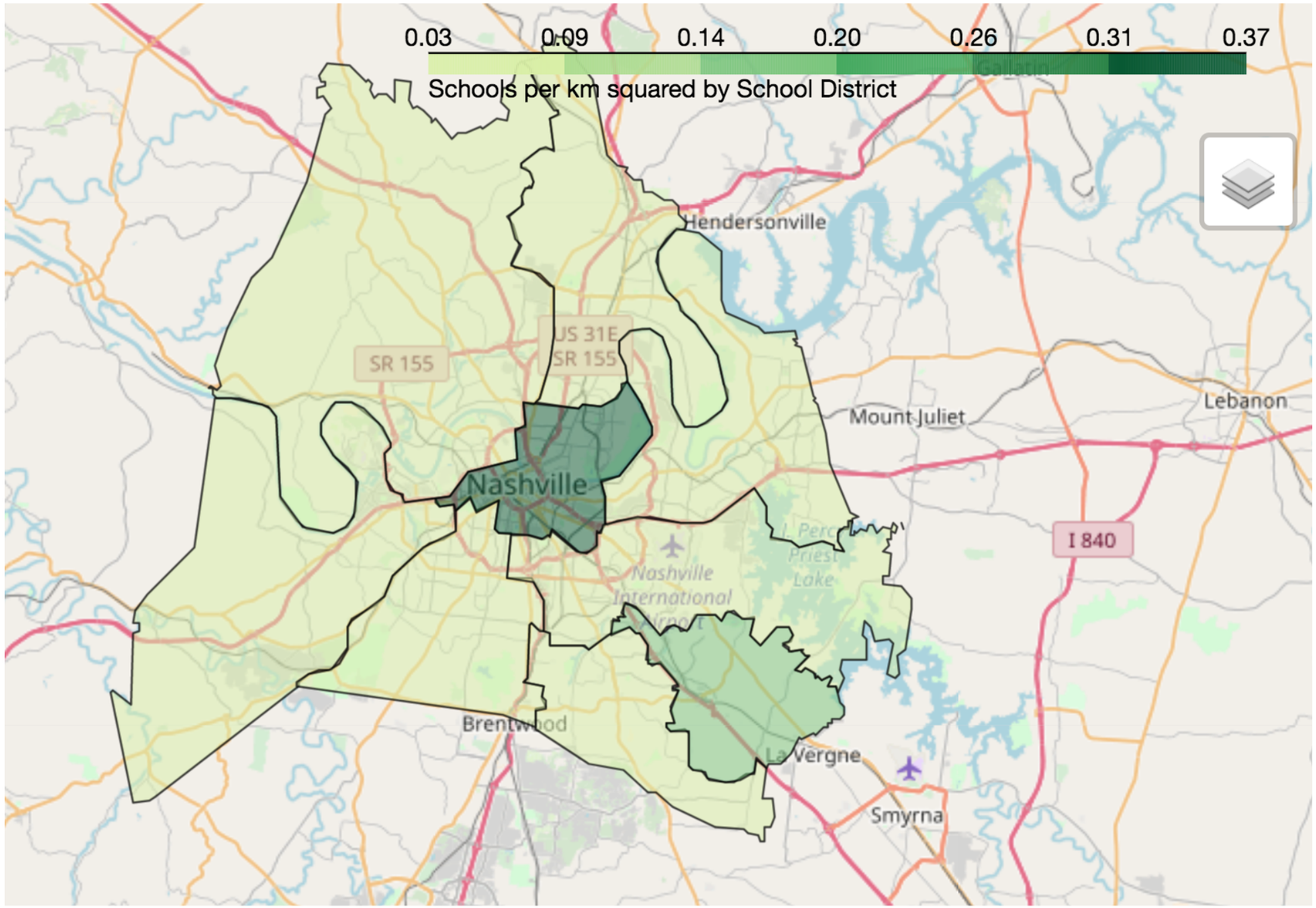
- `key_on` - a GeoJSON variable to bind the data to (always starts with `feature`)
- `fill_color` - polygon fill color (defaults to blue)
- `fill_opacity` - range between 0 (transparent) and 1 (completely opaque)
- `line_color` - color of polygon border lines (defaults to black)
- `line_opacity` - range between 0 (transparent) and 1 (completely opaque)
- `legend_name` - creates a title for the legend

```
# Center point and map for Nashville
nashville = [36.1636,-86.7823]
m = folium.Map(location=nashville, zoom_start=10)
```

```
# Define a choropleth layer for the map
m.choropleth(
    geo_data=districts_with_counts,
    name='geometry',
    data=districts_with_counts,
    columns=['district', 'school_density'],
    key_on='feature.properties.district',
    fill_color='YlGn',
    fill_opacity=0.75,
    line_opacity=0.5,
    legend_name='Schools per km squared by School District'
   )
```

```
# Add layer control and display
folium.LayerControl().add_to(m)
display(m)
```

Folium choropleth of school density



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Congratulations!

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Skills list

- how to work with shapefiles and GeoJSON
- how to work with geometries
- how to use geopandas, shapely, and folium to extract meaning from geospatial data
- how to create beautiful and informative geospatial visualizations


WARNING!
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Goodbye

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