

# HONR 490 – Homework 5

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February 26, 2021

**DUE DATE:** 2021/09/27 23:59 EDT

## Homework Instructions

To receive credit for the assignment, do the following:

1. Create an `.ipynb` file, and name it: `purduealias_honr490_homework_number.ipynb` (e.g., `gould29_honr490_homework_1.ipynb`)
2. Show all your work and follow the instructions below very carefully.
3. Submit a printout (e.g., as PDF) of your `.ipynb` file—and the file itself—to Brightspace by the due date.
4. You must show **all** your work and provide comments in your code explaining what you are doing. **You must display your SQL query (queries), ALL GeoDataFrame(s), and maps (via `.plot()`) to receive any credit!** I will tell you what columns to include. You will not be marked down for including additional columns—only failing to provide what is asked.

For grading this assignment, I will not leverage unit tests. I will look at the printout of your `.ipynb` file. When in doubt, please show and comment all your work.

All files and data you need to complete this assignment are located on GitHub, under the Homework 5 folder. It contains the following:

- `./t1_2015_26_prisecroads`: A folder containing a shapefile (and supporting files) of Michigan's limited access highways.
- `./t1_2016_26_cousub`: A folder containing a shapefile (and supporting files) of Michigan's counties.
- `./ch11`: A folder containing the data used in weeks 5-6 lectures, from chapter 11 of our textbook. *If you followed along our lecture notebook, loading the data into your Postgres database was already done.*

## Problem 1

### Split a POLYGON—4 Points

Please create a geometry collection consisting of 2 halves of a right-hand-winding polygon, based on the following:

**Input:** Below are the shapes you will use in your SQL query. Split the POLYGON with the LINESTRING

- POLYGON:

```
ST_Buffer(  
  ST_ForceRHR(  
    ST_Boundary(  
      ST_GeomFromText('POLYGON ((50 50, 50 150, 150 150, 150 50, 50 50))')  
    )  
  ),  
  20,'side=right')
```

- LINESTRING: ST\_MakeLine(ST\_MakePoint(10, 10),ST\_MakePoint(190, 190))

#### Desired Outputs:

1. (2 points) Correct SQL query text shown.
2. (1 point) Showing the `.head()` of your `GeoDataFrame`. Columns to include:
  - (a) Geometry
  - (b) Geometry type
3. (1 point) Showing the `.plot()` of your `GeoDataFrame`.

## Problem 2

### Dividing San Francisco into Hexagons—4 Points

Using the `ch11.stclines_streets` dataset from our lecture, split the road network of the San Francisco into hexagons of  $500ft^2$ . Your geometry's CRS should be WGS 84.

**Input:** The `ch11.stclines_streets` dataset.

#### Desired Outputs:

1. (2 points) Correct SQL query text shown.
2. (1 point) Showing the `.head()` of your `GeoDataFrame`. Columns to include:
  - (a) Geometry
  - (b) The row number along the grid,  $i$
  - (c) The column number along the grid,  $j$
  - (d) The number of streets contained within each hexagon
  - (e) Order the `GeoDataFrame` by the number of streets within each hexagon descending
3. (1 point) Showing the `.plot()` of your `GeoDataFrame`.

### Problem 3

**Create a LINESTRING from a Series of POINTs—4 Points**

Using the `ch11.aussie_track_points` dataset from our lecture, return a `LINESTRING` containing all chronologically-ordered points for each race (`track_fid`). Please transform your coordinates into WGS 84 / Pseudo-Mercator.

**Input:** The `ch11.aussie_track_points` dataset.

**Desired Outputs:**

1. (2 points) Correct SQL query text shown.
2. (1 point) Showing the `.head()` of your `GeoDataFrame`. Columns to include:
  - (a) Race ID (`track_fid`)
  - (b) Geometry
  - (c) The race's start time
  - (d) The race's end time
  - (e) The length of each race in meters
  - (f) Order the `GeoDataFrame` by the `track_fid` ascending
3. (1 point) Showing the `.plot()` of your `GeoDataFrame`.

### Problem 4

**Create a MULTILINESTRING of all Races from Problem 3—1 Point**

Using the result of problem 3, please combine every race's `LINESTRING` into a single `MULTILINESTRING`.

**Input:** The `GeoDataFrame` from problem 3.

**Desired Outputs:**

1. (0.50 points) Correct SQL query text shown.
2. (0.25 point) Showing the `.head()` of your `GeoDataFrame`. Columns to include:
  - (a) Geometry
3. (0.25 points) Showing the `.plot()` of your `GeoDataFrame`.

## Problem 5

### Determining which County in Michigan Has the Highest Mileage of Limited-Access Highways—12 Points

Michigan—particularly the Detroit area—is known for having many highways. Please determine if this is, indeed, true. Given the shapefiles for both the counties (`POLYGON`) and limited-access highways (`LINESTRING`) in the state of Michigan, please determine the total mileage of limited-access highways belonging to each county in Michigan.

**Input:** The shapefiles contained within the `tl_2015_26_prisecroads` and `tl_2016_26_cousub` folders provided in this homework directory.

**Desired Outputs:** You will be required to provide a `GeoDataFrame` and a `pandas.DataFrame`. Please see the below requirements:

1. (8 points) Correct SQL query text to generate the `GeoDataFrame` shown.
2. (1 point) Showing the `.head()` of your `GeoDataFrame`. Columns to include:
  - (a) County name
  - (b) Highway name
  - (c) Highway ID (`LINEARID`)
  - (d) Geometry of the portion of a given highway within a county's `POLYGON`
  - (e) Length of the geometry of the portion of a given highway within a county's `POLYGON`, in miles
3. (1 points) Showing the `.plot()` of your `GeoDataFrame`.
4. (2 points) Showing a `pandas.DataFrame` with the following columns:
  - (a) County name
  - (b) Sum of the length of highway portions within the county's `POLYGON`, in miles. **Convert the `GeoDataFrame` into a `Pandas DataFrame` to perform aggregation.**
  - (c) Order the `pandas.DataFrame` by the summed highway length descending

**TIP:** The SQL query to generate the `GeoDataFrame` may take a couple minutes to run. To test your logic, I suggest running on a subset of counties (via SQL's `LIMIT` function, before applying to all data once your query behaves as desired.)

**HINT:** In order to return lengths in miles, you will need to change both the county and highway CRS. This can be done by changing to a CRS providing lengths and distances in either meters or feet, and calculating a simple conversion.