

Pset 5

2024-11-09

Due 11/9 at 5:00PM Central. Worth 100 points + 10 points extra credit.

Submission Steps (10 pts)

1. This problem set is a paired problem set.
2. Play paper, scissors, rock to determine who goes first. Call that person *Partner 1*.
 - Partner 1 : Shuping Wu,
 - Partner 2 : Sijie Wu, sijiewu
3. Partner 1 will accept the `ps5` and then share the link it creates with their partner. You can only share it with one partner so you will not be able to change it after your partner has accepted.
4. “This submission is our work alone and complies with the 30538 integrity policy.” Add your initials to indicate your agreement: **__** **__**
5. “I have uploaded the names of anyone else other than my partner and I worked with on the problem set [here](#)” (1 point)
6. Late coins used this pset: **__** Late coins left after submission: **__**
7. Knit your `ps5.qmd` to an PDF file to make `ps5.pdf`,
 - The PDF should not be more than 25 pages. Use `head()` and re-size figures when appropriate.
8. (Partner 1): push `ps5.qmd` and `ps5.pdf` to your github repo.
9. (Partner 1): submit `ps5.pdf` via Gradescope. Add your partner on Gradescope.
10. (Partner 1): tag your submission in Gradescope

```
import pandas as pd
import altair as alt
import time

import warnings
warnings.filterwarnings('ignore')
alt.renderers.enable("png")
```

```
RendererRegistry.enable('png')
```

```
import requests
from bs4 import BeautifulSoup
from bs4.element import Tag
```

Step 1: Develop initial scraper and crawler

1. Scraping (PARTNER 1)

```
# Step 1: Fetch the webpage
url = "https://oig.hhs.gov/fraud/enforcement/"
response = requests.get(url)
soup = BeautifulSoup(response.text, 'html.parser')

# Step 2: Scrape required data
titles = []
dates = []
categories = []
links = []

for action in soup.select('header.usa-card__header'):

    title_tag = action.select_one('h2.usa-card__heading a')
    title = title_tag.text.strip()
    link = "https://oig.hhs.gov" + title_tag['href']
    date_tag = action.select_one('div.font-body-sm.margin-top-1 span')
    date = date_tag.text.strip()
    cat_tag = action.select_one('div.font-body-sm.margin-top-1 ul')
    categories.append(cat_tag.text.strip())
    titles.append(title)
```

```
links.append(link)
dates.append(date)
```

```
df = pd.DataFrame({
    'Title': titles,
    'Date': dates,
    'Category': categories,
    'Link': links
})
print(df.head())
```

```
          Title          Date \
0  Pharmacist and Brother Convicted of $15M Medic...  November 8, 2024
1  Boise Nurse Practitioner Sentenced To 48 Month...  November 7, 2024
2  Former Traveling Nurse Pleads Guilty To Tamper...  November 7, 2024
3  Former Arlington Resident Sentenced To Prison ...  November 7, 2024
4  Paroled Felon Sentenced To Six Years For Fraud...  November 7, 2024

          Category \
0  Criminal and Civil Actions
1  Criminal and Civil Actions
2  Criminal and Civil Actions
3  Criminal and Civil Actions
4  Criminal and Civil Actions

          Link
0  https://oig.hhs.gov/fraud/enforcement/pharmaci...
1  https://oig.hhs.gov/fraud/enforcement/boise-nu...
2  https://oig.hhs.gov/fraud/enforcement/former-t...
3  https://oig.hhs.gov/fraud/enforcement/former-a...
4  https://oig.hhs.gov/fraud/enforcement/paroled-...
```

```
agencies = []
for link in df['Link']:
    detail_response = requests.get(link)
    detail_soup = BeautifulSoup(detail_response.text, 'html.parser')
    agency_tag = detail_soup.select(
        'ul.usa-list.usa-list--unstyled.margin-y-2 li')
    second_li = agency_tag[1]
    if not isinstance(second_li.contents[1], Tag):
        agency = second_li.contents[1].strip()
```

```

else:
    agency = 'NaN'
    agencies.append(agency)
# df['Agency'] = agencies
print(agencies)

```

['U.S. Department of Justice', "November 7, 2024; U.S. Attorney's Office, District of Idaho", "U.S. Attorney's Office, District of Massachusetts", "U.S. Attorney's Office, Eastern District of Virginia", "U.S. Attorney's Office, Middle District of Florida", "U.S. Attorney's Office, Western District of Texas", "U.S. Attorney's Office, Eastern District of Michigan", "U.S. Attorney's Office, Eastern District of Tennessee", "U.S. Attorney's Office, Northern District of Texas", 'U.S. Department of Justice', 'State of South Carolina', "U.S. Attorney's Office, Eastern District of Missouri", "U.S. Attorney's Office, Middle District of Tennessee", 'U.S. Department of Justice', 'State of New Mexico', 'State of Tennessee', 'NaN', 'Ohio', 'NaN', 'State of Massachusetts']

```

df['Agency'] = agencies
print(df.head())

```

	Title	Date	\
0	Pharmacist and Brother Convicted of \$15M Medic...	November 8, 2024	
1	Boise Nurse Practitioner Sentenced To 48 Month...	November 7, 2024	
2	Former Traveling Nurse Pleads Guilty To Tamper...	November 7, 2024	
3	Former Arlington Resident Sentenced To Prison ...	November 7, 2024	
4	Paroled Felon Sentenced To Six Years For Fraud...	November 7, 2024	

	Category	\
0	Criminal and Civil Actions	
1	Criminal and Civil Actions	
2	Criminal and Civil Actions	
3	Criminal and Civil Actions	
4	Criminal and Civil Actions	

	Link	\
0	https://oig.hhs.gov/fraud/enforcement/pharmaci...	
1	https://oig.hhs.gov/fraud/enforcement/boise-nu...	
2	https://oig.hhs.gov/fraud/enforcement/former-t...	
3	https://oig.hhs.gov/fraud/enforcement/former-a...	
4	https://oig.hhs.gov/fraud/enforcement/paroled-...	

	Agency
0	U.S. Department of Justice
1	November 7, 2024; U.S. Attorney's Office, Dist...
2	U.S. Attorney's Office, District of Massachusetts
3	U.S. Attorney's Office, Eastern District of Vi...
4	U.S. Attorney's Office, Middle District of Flo...

2. Crawling (PARTNER 1)

```
#
```

Step 2: Making the scraper dynamic

1. Turning the scraper into a function

- a. Pseudo-Code (PARTNER 2) First, check date input.

Then, create a loop to read in the current url.

Create a for loop to loop in the current page, checking the date of each entry every time, stop when reached date limit.

Proceed to the next page if not reached start date.

- b. Create Dynamic Scraper (PARTNER 2)

```
from datetime import datetime
import time

def scrape_enforcement_actions(month, year):
    if year < 2013:
        print("Year must be 2013 or later.")
        return

    start_date = datetime(year, month, 1)

    base_url = "https://oig.hhs.gov/fraud/enforcement/?page="
    actions_data = []
    page_number = 1
    done = False
```

```

while not done:
    url = f"{base_url}{page_number}"
    response = requests.get(url)
    soup = BeautifulSoup(response.text, 'html.parser')

    actions = soup.select('header.usa-card__header')

    for action in actions:
        date_tag = action.select_one('div.font-body-sm.margin-top-1
↪ span')
        date = date_tag.text.strip()
        print(date)
        action_date = datetime.strptime(date, "%B %d, %Y")

        if start_date <= action_date:
            title_tag = action.select_one('h2.usa-card__heading a')
            title = title_tag.text.strip()
            print(title)
            link = "https://oig.hhs.gov" + title_tag['href']
            category = action.select_one(
                'li.display-inline-block.usa-tag.text-no-lowercase').text.strip()
            agency = scrape_agency(link)
            print(agency)

            actions_data.append({
                'Title': title,
                'Date': action_date.strftime("%Y-%m-%d"),
                'Category': category,
                'Link': link,
                'Agency': agency
            })
        elif action_date < start_date:
            done = True
            break

    page_number += 1
    time.sleep(1)

# Save to CSV
df = pd.DataFrame(actions_data)

```

```

file_name = f"enforcement_actions_{year}_{month}.csv"
df.to_csv(file_name, index=False)
print(f"Data saved to {file_name}")

```

```

def scrape_agency(link):
    detail_response = requests.get(link)
    detail_soup = BeautifulSoup(detail_response.text, 'html.parser')
    agency_tag = detail_soup.select(
        'ul.usa-list.usa-list--unstyled.margin-y-2 li')
    second_li = agency_tag[1]
    if not isinstance(second_li.contents[1], Tag):
        agency = second_li.contents[1].strip()
    else:
        agency = 'NaN'
    return agency

```

- c. Test Partner's Code (PARTNER 1)

```
#scrape_enforcement_actions(1, 2021)
```

Step 3: Plot data based on scraped data

1. Plot the number of enforcement actions over time (PARTNER 2)

```

filepath = "enforcement_actions_2021_1.csv"
data = pd.read_csv(filepath)
data.head()

```

	Title	Date	Category	Link
0	Former Arlington Resident Sentenced To Prison ...	2024-11-07	Criminal and Civil Actions	https:/
1	Paroled Felon Sentenced To Six Years For Fraud...	2024-11-07	Criminal and Civil Actions	https:/
2	Former Licensed Counselor Sentenced For Defrau...	2024-11-06	Criminal and Civil Actions	https:/
3	Macomb County Doctor And Pharmacist Agree To P...	2024-11-04	Criminal and Civil Actions	https:/
4	Rocky Hill Pharmacy And Its Owners Indicted Fo...	2024-11-04	Criminal and Civil Actions	https:/

```
import altair as alt
from altair_saver import save

# Change "Date" into datetime format
data['Date'] = pd.to_datetime(data['Date'])

# Aggregate by month and year
monthly_actions = data.groupby(data['Date'].dt.to_period(
    "M")).size().reset_index(name='count')
monthly_actions['Date'] = monthly_actions['Date'].dt.to_timestamp()

# Plot with Altair
chart1 = alt.Chart(monthly_actions).mark_line().encode(
    x=alt.X('Date:T', title='Date', axis=alt.Axis(format='%Y-%m')),
    y=alt.Y('count:Q', title='Number of Enforcement Actions'),
    tooltip=['Date:T', 'count:Q']
).properties(
    title='Number of Enforcement Actions Over Time (Monthly Aggregation)',
    width=400,
    height=200
)
chart1.save('/Users/wsjsmac/Desktop/Autumn/PPHA_30538/mine/Pset_5/pair-from-git/problemset5/
```

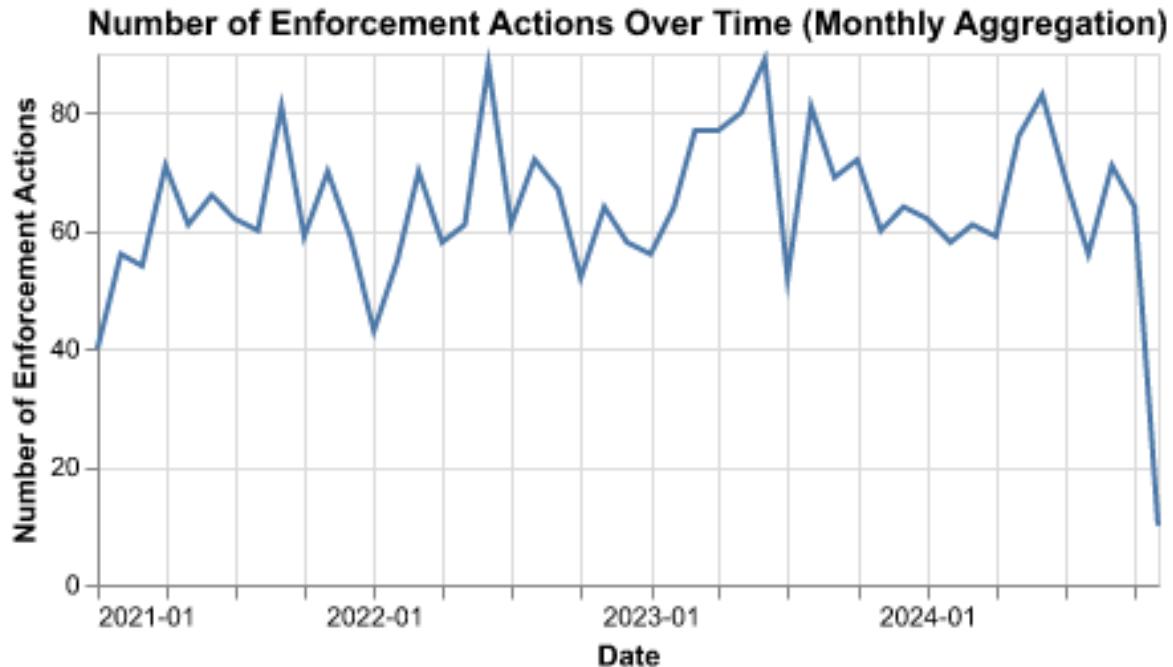


Figure 1: Number of Enforcement Actions Over Time

2. Plot the number of enforcement actions categorized: (PARTNER 1)

- based on “Criminal and Civil Actions” vs. “State Enforcement Agencies”

```
# Change "Date" into datetime format
data['Date'] = pd.to_datetime(data['Date'])

# Aggregate by month and year, and by category
monthly_actions = (
    data[data['Category'].isin(
        ['Criminal and Civil Actions', 'State Enforcement Agencies'])]
    .groupby([data['Date'].dt.to_period("M"), 'Category'])
    .size()
    .reset_index(name='Count')
)

# Convert 'Date' back to timestamp for plotting
monthly_actions['Date'] = monthly_actions['Date'].dt.to_timestamp()

# Plot with Altair
```

```

chart2 = alt.Chart(monthly_actions).mark_line().encode(
    x=alt.X('Date:T', title='Date', axis=alt.Axis(format='%Y-%m')),
    y=alt.Y('Count:Q', title='Number of Enforcement Actions'),
    color=alt.Color('Category:N', title='Category'),
    tooltip=['Date:T', 'Count:Q', 'Category:N']
).properties(
    title='Number of Enforcement Actions Over Time by Category',
    width=400,
    height=200
).interactive()

# chart2

chart2.save('/Users/wsjsmac/Desktop/Autumn/PPHA_30538/mine/Pset_5/pair-from-git/problemset5/
```

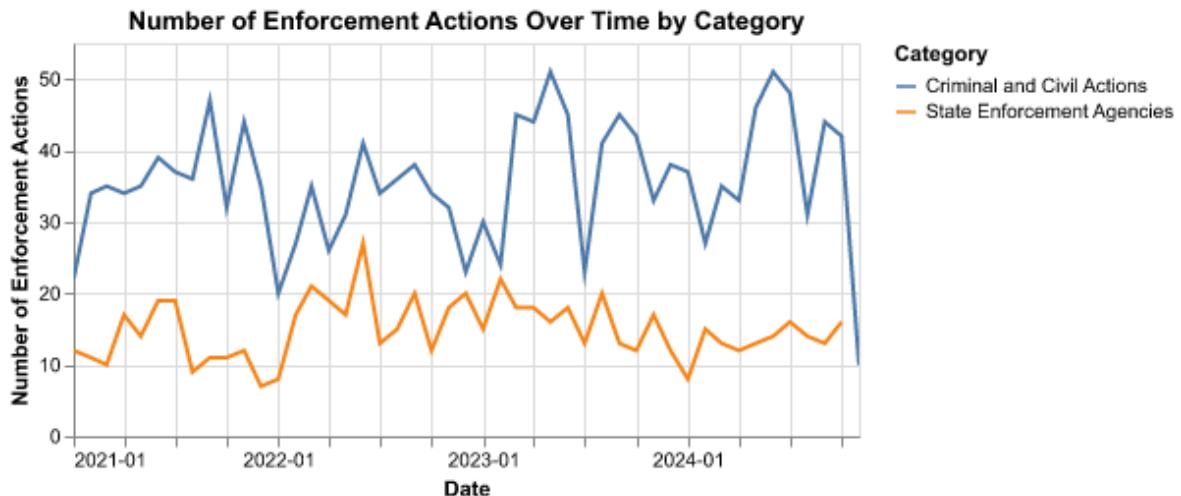


Figure 2: Number of Enforcement Actions Over Time by Category

- based on five topics

```

# Change "Date" into datetime format
data['Date'] = pd.to_datetime(data['Date'])

data_criminal_civil = data[data['Category'].isin(
    ['Criminal and Civil Actions'])]

# Define a function to categorize based on keywords in 'Title'
```

```

def categorize_title(title):
    if any(keyword in title.lower() for keyword in ['drug', 'narcotics',
        'enforcement', 'trafficking']):
        return 'Drug Enforcement'
    elif any(keyword in title.lower() for keyword in ['health', 'insurance',
        'hospital', 'medicare', 'medicaid']):
        return 'Health Care Fraud'
    elif any(keyword in title.lower() for keyword in ['bank', 'financial',
        'investment', 'securities']):
        return 'Financial Fraud'
    elif any(keyword in title.lower() for keyword in ['bribery',
        'corruption', 'bribe']):
        return 'Bribery/Corruption'
    else:
        return 'Other'

# Apply categorization function to the Title column
data_criminal_civil['Topic'] = data_criminal_civil['Title'].apply(
    categorize_title)

data_criminal_civil.head()

```

	Title	Date	Category	Link
0	Former Arlington Resident Sentenced To Prison ...	2024-11-07	Criminal and Civil Actions	https:/
1	Paroled Felon Sentenced To Six Years For Fraud...	2024-11-07	Criminal and Civil Actions	https:/
2	Former Licensed Counselor Sentenced For Defrau...	2024-11-06	Criminal and Civil Actions	https:/
3	Macomb County Doctor And Pharmacist Agree To P...	2024-11-04	Criminal and Civil Actions	https:/
4	Rocky Hill Pharmacy And Its Owners Indicted Fo...	2024-11-04	Criminal and Civil Actions	https:/

```

# Aggregate by month and year, and by topic
monthly_actions = (
    data_criminal_civil
    .groupby([data_criminal_civil['Topic'],
        data_criminal_civil['Date'].dt.to_period("M")])
    .size()
    .reset_index(name='Count')
)

```

```

# Convert 'Date' back to timestamp for plotting
monthly_actions['Date'] = monthly_actions['Date'].dt.to_timestamp()

# Plot with Altair
chart3 = alt.Chart(monthly_actions).mark_line().encode(
    x=alt.X('Date:T', title='Date', axis=alt.Axis(format='%Y-%m')),
    y=alt.Y('Count:Q', title='Number of Categories'),
    color=alt.Color('Topic:N', title='Topic'),
    tooltip=['Date:T', 'Count:Q', 'Topic:N']
).properties(
    title='Number of Criminal and Civil Actions Over Time by Topic',
    width=400,
    height=200
).interactive()

#chart3

chart3.save('/Users/wsjsmac/Desktop/Autumn/PPHA_30538/mine/Pset_5/pair-from-git/problemset5/'

```

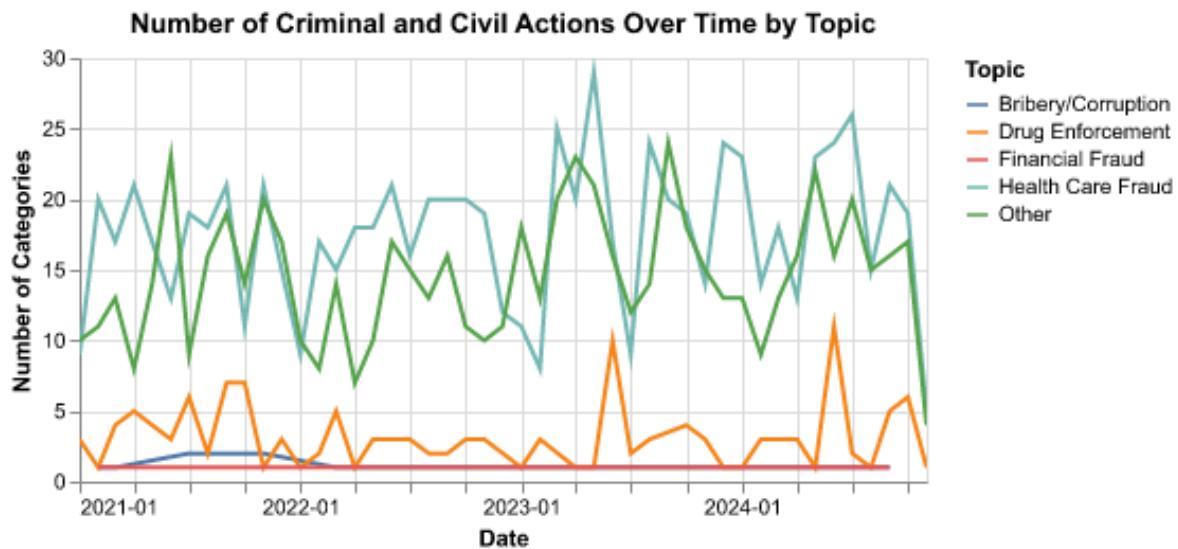


Figure 3: Number of Criminal and Civil Actions Over Time by Topic

Step 4: Create maps of enforcement activity

1. Map by State (PARTNER 1)

```
filepath = "enforcement_actions_2021_1.csv"
data = pd.read_csv(filepath)
data.head()
```

	Title	Date	Category	Link
0	Former Arlington Resident Sentenced To Prison ...	2024-11-07	Criminal and Civil Actions	https://
1	Paroled Felon Sentenced To Six Years For Fraud...	2024-11-07	Criminal and Civil Actions	https://
2	Former Licensed Counselor Sentenced For Defrau...	2024-11-06	Criminal and Civil Actions	https://
3	Macomb County Doctor And Pharmacist Agree To P...	2024-11-04	Criminal and Civil Actions	https://
4	Rocky Hill Pharmacy And Its Owners Indicted Fo...	2024-11-04	Criminal and Civil Actions	https://

```
data_state = data[data["Agency"].str.contains("State of", case=False,
                                             na=False)]
data_state = data_state.reset_index(drop=True)
data_state.head()
```

	Title	Date	Category	Link
0	Quincy-Based Physician Group To Pay \$650,000 T...	2024-10-30	State Enforcement Agencies	https://
1	AG's Office Reaches Settlement With Swamprscott...	2024-10-29	State Enforcement Agencies	https://
2	Attorney General Griffin Announces Medicaid Fr...	2024-10-25	State Enforcement Agencies	https://
3	Attorney General Alan Wilson Announces Spartan...	2024-10-24	State Enforcement Agencies	https://
4	Stamford Woman Charged In Scheme To Defraud Me...	2024-10-22	State Enforcement Agencies	https://

```
import geopandas as gpd
# Load the shapefile
states_gdf = gpd.read_file("cb_2018_us_state_500k/cb_2018_us_state_500k.shp")
# Replace with the actual path to your shapefile
states_gdf.head()
```

	STATEFP	STATENS	AFFGEOID	GEOID	STUSPS	NAME	LSAD	ALAND	...
0	28	01779790	0400000US28	28	MS	Mississippi	00	121533519481	3

	STATEFP	STATENS	AFFGEOID	GEOID	STUSPS	NAME	LSAD	ALAND	AWA
1	37	01027616	0400000US37	37	NC	North Carolina	00	125923656064	1
2	40	01102857	0400000US40	40	OK	Oklahoma	00	177662925723	3
3	51	01779803	0400000US51	51	VA	Virginia	00	102257717110	8
4	54	01779805	0400000US54	54	WV	West Virginia	00	62266474513	4

```
state_count = (
    data_state
    .groupby('Agency')
    .size()
    .reset_index(name='Count')
)
state_count.head()
```

	Agency	Count
0	State of Arizona	1
1	State of Arkansas	2
2	State of California	3
3	State of Colorado	3
4	State of Connecticut	4

```
state_count["Agency_Name"] = state_count['Agency'].str.replace(r'^State of ',
    '', regex=True)
```

```
# Ensure state names/abbreviations match in both DataFrames
merged_gdf = states_gdf.merge(state_count, left_on='NAME',
    right_on='Agency_Name', how='right')

merged_gdf.head()
```

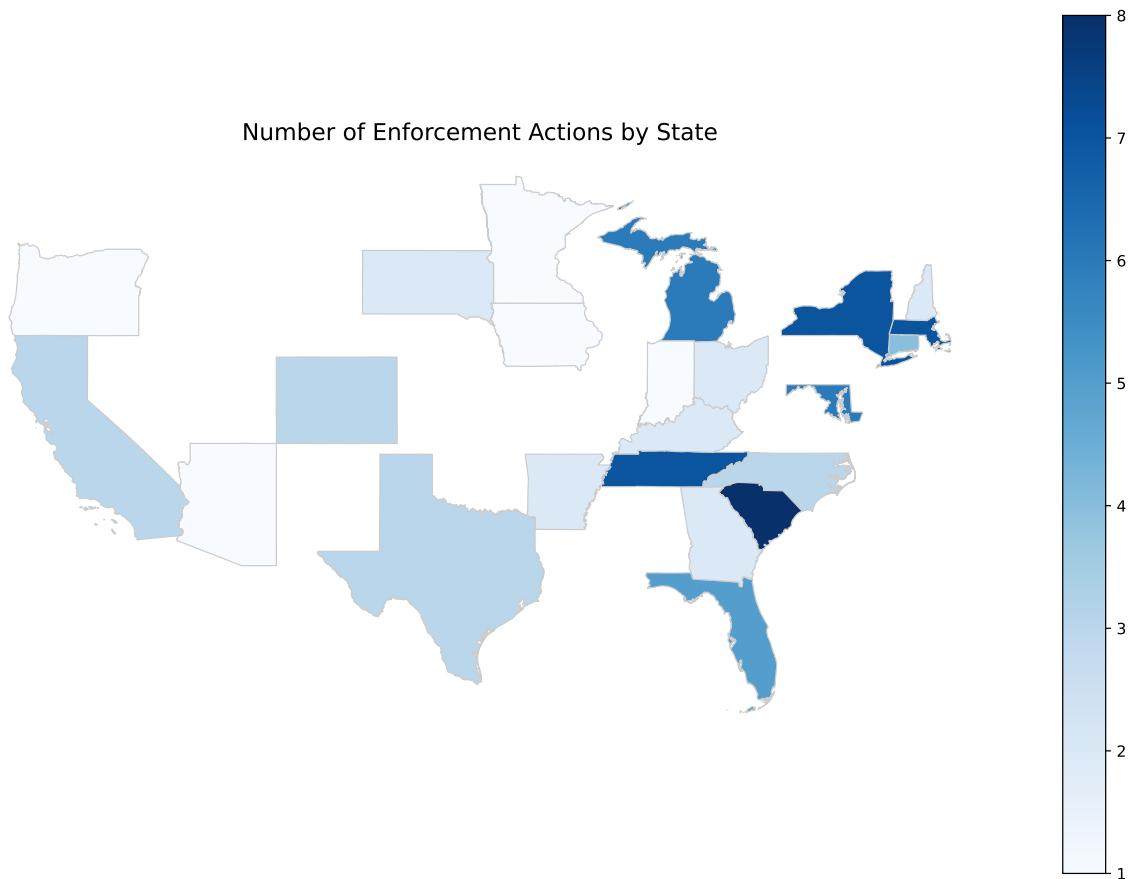
	STATEFP	STATENS	AFFGEOID	GEOID	STUSPS	NAME	LSAD	ALAND	AWA
0	04	01779777	0400000US04	04	AZ	Arizona	00	294198551143	1027
1	05	00068085	0400000US05	05	AR	Arkansas	00	134768872727	2962
2	06	01779778	0400000US06	06	CA	California	00	403503931312	2046
3	08	01779779	0400000US08	08	CO	Colorado	00	268422891711	1181
4	09	01779780	0400000US09	09	CT	Connecticut	00	12542497068	1815

```

import matplotlib.pyplot as plt

# Plotting the map
fig, ax = plt.subplots(1, 1, figsize=(15, 10))
merged_gdf.plot(column='Count', cmap='Blues', linewidth=0.8, edgecolor='0.8',
                 legend=True, ax=ax)
ax.set_title("Number of Enforcement Actions by State", fontsize=15)
ax.set_axis_off()
plt.show()

```



2. Map by District (PARTNER 2)

```

import geopandas as gpd
filepath1 =
    "/Users/wsjsmac/Desktop/Autumn/PPHA_30538/mine/Pset_5/pair-from-git/problemset5/enforceme

```

```

data = pd.read_csv(filepath1)
filepath =
↳ "/Users/wsjsmac/Desktop/Autumn/PPHA_30538/mine/Pset_5/pair-from-git/problemset5/US
↳ Attorney Districts Shapefile
↳ simplified_20241109/geo_export_c632cc9b-772f-489b-8052-e9829f5262fb.shp"
district = gpd.read_file(filepath)

```

```

district.head()

```

	statefp	judicial_d	aland	awater	state	chief_judg
0	21	Western District of Kentucky	4.970555e+10	1.651516e+09	Kentucky	Greg N. Stivers
1	21	Eastern District of Kentucky	5.257394e+10	7.238213e+08	Kentucky	Danny Reeves
2	18	Southern District of Indiana	5.824517e+10	5.941176e+08	Indiana	Jane Magnus-Stinson
3	01	Middle District of Alabama	3.412673e+10	5.472423e+08	Alabama	Emily Coody Marks
4	01	Southern District of Alabama	6.235882e+10	3.052681e+09	Alabama	Kristi DuBose

```

data_district = data[data["Agency"].str.contains("District", case=False,
↳ na=False)]
data_district = data_district.reset_index(drop=True)

district_count = (
    data_district
    .groupby('Agency')
    .size()
    .reset_index(name='Count')
)

```

```

def extract_district(agency):
    if 'Attorney's Office, ' in agency: # Case with 'Attorney's Office, '
        return agency.split("Attorney's Office, ")[-1]
    elif 'Attorney\'s Office, ' in agency: # Case with 'Attorney\'s Office,
    ↳ '
        return agency.split("Attorney's Office, ")[-1]
    elif 'U.S. Attorney's Office;' in agency: # Case with 'U.S. Attorney's
    ↳ Office; '
        return agency.split("U.S. Attorney's Office;)[-1]
    elif 'U.S. Attorney's Office' in agency: # Case with 'U.S. Attorney's
    ↳ Office; '
        return agency.split("U.S. Attorney's Office")[-1]

```

```

    elif "U.S. Attorney General," in agency:
        return agency.split("U.S. Attorney General,")[-1]
    elif "U.S. Attorney's Office," in agency:
        return agency.split("U.S. Attorney's Office,")[-1]
    else: # For cases without the expected prefixes
        return agency

# Apply the function to the 'Agency' column
district_count['Agency_Name'] =
    district_count['Agency'].apply(extract_district)

district_count.head()

```

	Agency	Count	Agency_Name
0	2021; U.S. Attorney's Office, Northern District of Florida	1	Northern District of Florida
1	Attorney's Office, Northern District of Illinois	1	Northern District of Illinois
2	Attorney's Office, District of New Jersey	1	District of New Jersey
3	Attorney's Office, District of Rhode Island	1	District of Rhode Island
4	Attorney's Office, Northern District of Texas	1	Northern District of Texas

```

# Ensure state names/abbreviations match in both DataFrames
merged = district.merge(district_count, left_on='judicial_d',
    right_on='Agency_Name', how='right')

merged.head()

```

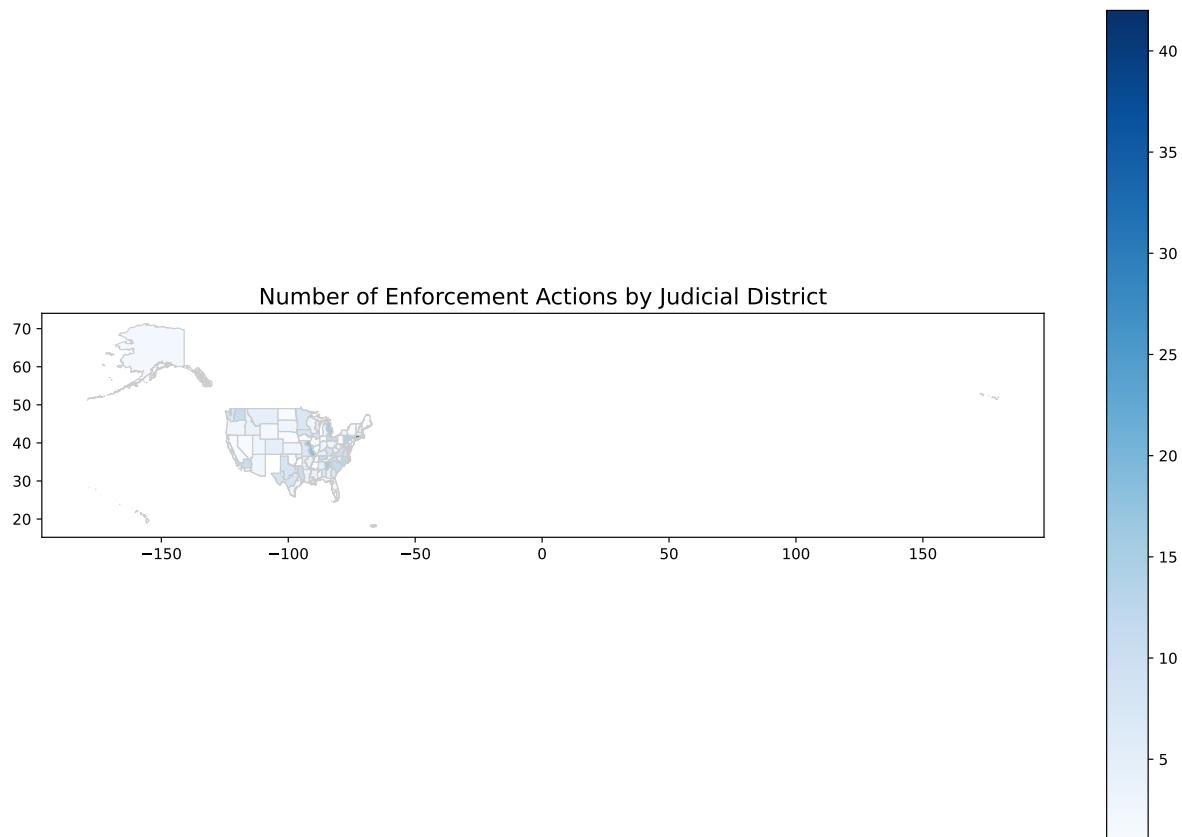
	statefp	judicial_d	aland	awater	state	chief_judg
0	12	Northern District of Florida	4.298844e+10	7.156926e+09	Florida	Mark E. Walker
1	17	Northern District of Illinois	2.784832e+10	4.525031e+09	Illinois	Rebecca Pallmeyer
2	34	District of New Jersey	1.904788e+11	3.544860e+09	New Jersey	Freda Wolfson
3	44	District of Rhode Island	2.677780e+09	1.323670e+09	Rhode Island	John J. McConnell
4	48	Northern District of Texas	2.485411e+11	2.139065e+09	Texas	Barbara Lynn

```

import matplotlib.pyplot as plt
# Plotting the map
# Set limits to focus on the contiguous U.S.
ax.set_xlim(-130, -60) # Adjust these limits based on the actual extent
ax.set_ylim(20, 55)

```

```
fig, ax = plt.subplots(1, 1, figsize=(15, 10), dpi=150)
merged.plot(column='Count', cmap='Blues', linewidth=0.8, edgecolor='0.8',
    legend=True, ax=ax, aspect=1.5)
ax.set_title("Number of Enforcement Actions by Judicial District",
    fontsize=15)
plt.show()
```



Extra Credit

1. Merge zip code shapefile with population

```
#
```

2. Conduct spatial join

3. Map the action ratio in each district

#