Problem Set 4

Minyang Xu

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Due 02/07 at 5:00PM Central.

"This submission is my work alone and complies with the 30538 integrity policy." Add your initials to indicate your agreement: **MX**

Github Classroom Assignment Setup and Submission Instructions

1. **Accepting and Setting up the PS4 Assignment Repository**
   - Each student must individually accept the repository for the problem set from Github Classroom ("ps4") – https://classroom.github.com/a/SN587tiQ
     - You will be prompted to select your cnetid from the list in order to link your Github account to your cnetid.
     - If you can't find your cnetid in the link above, click "continue to next step" and accept the assignment, then add your name, cnetid, and Github account to this Google Sheet and we will manually link it: https://rb.gy/9u7fb6
   - If you authenticated and linked your Github account to your device, you should be able to clone your PS4 assignment repository locally.
   - Contents of PS4 assignment repository:
     - `ps4_template.qmd`: this is the Quarto file with the template for the problem set. You will write your answers to the problem set here.
2. **Submission Process**:
   - Knit your completed solution `ps4.qmd` as a pdf `ps4.pdf`.
     - Your submission does not need runnable code. Instead, you will tell us either what code you ran or what output you got.
   - To submit, push `ps4.qmd` and `ps4.pdf` to your PS4 assignment repository. Confirm on Github.com that your work was successfully pushed.

Grading

- You will be graded on what was last pushed to your PS4 assignment repository before the assignment deadline
- Problem sets will be graded for completion as: {missing (0%); - (incomplete, 50%); + (excellent, 100%)}
  - The percent values assigned to each problem denote how long we estimate the problem will take as a share of total time spent on the problem set, not the points they are associated with.
- In order for your submission to be considered complete, you need to push both your `ps4.qmd` and `ps4.pdf` to your repository. Submissions that do not include both files will automatically receive 50% credit.

```python
import pandas as pd
import altair as alt
import time
from datetime import datetime

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

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

Step 1: Develop initial scraper and crawler

```python
import requests
from bs4 import BeautifulSoup

url = 'https://oig.hhs.gov/fraud/enforcement/'
response = requests.get(url)
soup = BeautifulSoup(response.text, 'lxml')

tags = soup.find_all('li', class_='usa-card')
rows = []

for card in tags:
    h2 = card.find("h2", class_="usa-card__heading")
    if h2 is None:
        continue

    a = h2.find("a")
    if a is None:
        continue

    title = a.text
    link = "https://oig.hhs.gov" + a["href"]

    date_span = card.find("span", class_="text-base-dark")
    if date_span is None:
        continue

    date = date_span.text
    category_li = card.find("li", class_="usa-tag")
    if category_li is None:
        continue

    category = category_li.text

    rows.append({
        "title": title,
        "date": date,
        "category": category,
        "link": link
    })

df = pd.DataFrame(rows)
print(df.head())
```

```
                                               title              date  \
0  Houston Transplant Doctor Indicted For Making ...  February 5, 2026
1  MultiCare Health System to Pay Millions to Set...  February 4, 2026
2  Brooklyn Banker Pleads Guilty to Laundering Pr...  February 3, 2026
3  Delafield Man Sentenced to 18 Months’ Imprison...  February 3, 2026
4  Former NFL Player Convicted for $197M Medicare...  February 3, 2026

                   category  \
0  Criminal and Civil Actions
1  Criminal and Civil Actions
2                  COVID-19
3  Criminal and Civil Actions
4  Criminal and Civil Actions

                                                link
0  https://oig.hhs.gov/fraud/enforcement/houston-...
1  https://oig.hhs.gov/fraud/enforcement/multicar...
2  https://oig.hhs.gov/fraud/enforcement/brooklyn...
3  https://oig.hhs.gov/fraud/enforcement/delafiel...
4  https://oig.hhs.gov/fraud/enforcement/former-n...
```

Step 2: Making the scraper dynamic

1. Turning the scraper into a function

- a. Pseudo-Code

```
FUNCTION scrape_enforcement_actions(month, year, indicator):

  If year < 2013:
    PRINT 'Restrict the input year to 2013 or later!'
    RETURN None

  If indicator is FALSE:
    PRINT 'scraper is turned off'
    RETURN None

  SET rows to empty list
  SET page_number to 0
  SET continue_scraping = TRUE

  WHILE continue_scraping is TRUE:
    CONSTRUCT URL for enforcement actions page using page_number
    SEND request to the URL
    PARSE the HTML content
    FIND all enforcement action entries on the page
    IF no enforcement actions are found:
      BREAK the loop

    FOR each enforcement action entry on the page:
      EXTRACT title, date, category, and link
      CONVERT extracted date to year-month format

      IF extracted date is earlier than the input year-month:
        SET continue_scraping = FALSE
        BREAK out of loop over entries

      ADD extracted information to all_actions

    WAIT for 1 second
    INCREMENT page_number by 1

  CONVERT all_actions into a dataframe
  SAVE dataframe as enforcement_actions_year_month.csv
  RETURN dataframe

END FUNCTION
```

- b. Create Dynamic Scraper

```python
def scrape_enforcement_actions(year, month, indicator=True):

    if year < 2013:
        print("Restrict to year after 2013!")
        return None

    if not indicator:
        print("Scraper is turned off.")
        return None

    threshold_date = datetime(year, month, 1)
    rows = []
    page = 0

    while True:
        url = f"https://oig.hhs.gov/fraud/enforcement/?page={page}"
        response = requests.get(url)
        soup = BeautifulSoup(response.text, "lxml")

        li_tags = soup.find_all("li", class_="usa-card")

        if not li_tags:
            break

        stop_scraping = False

        for li in li_tags:
            h2 = li.find("h2", class_="usa-card__heading")
            if h2 is None:
                continue

            a = h2.find("a")
            if a is None:
                continue

            title = a.text
            link = "https://oig.hhs.gov" + a["href"]

            date_span = li.find("span", class_="text-base-dark")
            if date_span is None:
                continue

            date_str = date_span.text
            date_time = datetime.strptime(date_str, "%B %d, %Y")

            if date_time < threshold_date:
                stop_scraping = True
                break

            category_li = li.find("li", class_="usa-tag")
            if category_li is None:
                continue

            category = category_li.text

            rows.append({
                "title": title,
                "date": date_time,
                "category": category,
                "link": link
            })

        if stop_scraping:
            break

        page += 1
        time.sleep(1)

    df = pd.DataFrame(rows)

    file = f"enforcement_actions_{year}_{month}.csv"
    df.to_csv(file, index=False)

    return df

df_2024 = scrape_enforcement_actions(2024, 1, indicator=True)

print("Total number of enforcement actions:", len(df_2024))
earliest_row = df_2024.sort_values("date").head(1).iloc[0]
print("\nEarliest enforcement action:")
print("Date:", earliest_row["date"])
print("Title:", earliest_row["title"])
print("Category:", earliest_row["category"])
print("Link:", earliest_row["link"])
```

```
Total number of enforcement actions: 1807
```

```
Earliest enforcement action:
Date: 2024-01-03 00:00:00
Title: Former Nurse Aide Indicted In Death Of Clarksville Patient Arrested In
Georgia
Category: State Enforcement Agencies
Link:
https://oig.hhs.gov/fraud/enforcement/former-nurse-aide-indicted-in-death-of-clarksville-pati
```

- c. Test Your Code

```
df_2022 = scrape_enforcement_actions(2022, 1, indicator=True)
print("Total number of enforcement actions:", len(df_2022))
earliest_row = df_2022.sort_values("date").head(1).iloc[0]
print("\nEarliest enforcement action:")
print("Date:", earliest_row["date"])
print("Title:", earliest_row["title"])
print("Category:", earliest_row["category"])
print("Link:", earliest_row["link"])
```

```
Total number of enforcement actions: 3397

Earliest enforcement action:
Date: 2022-01-04 00:00:00
Title: Integrated Pain Management Medical Group Agreed to Pay $10,000 for
Allegedly Violating the Civil Monetary Penalties Law by Employing Excluded
Individuals
Category: Fraud Self-Disclosures
Link:
https://oig.hhs.gov/fraud/enforcement/integrated-pain-management-medical-group-agreed-to-pay-
```

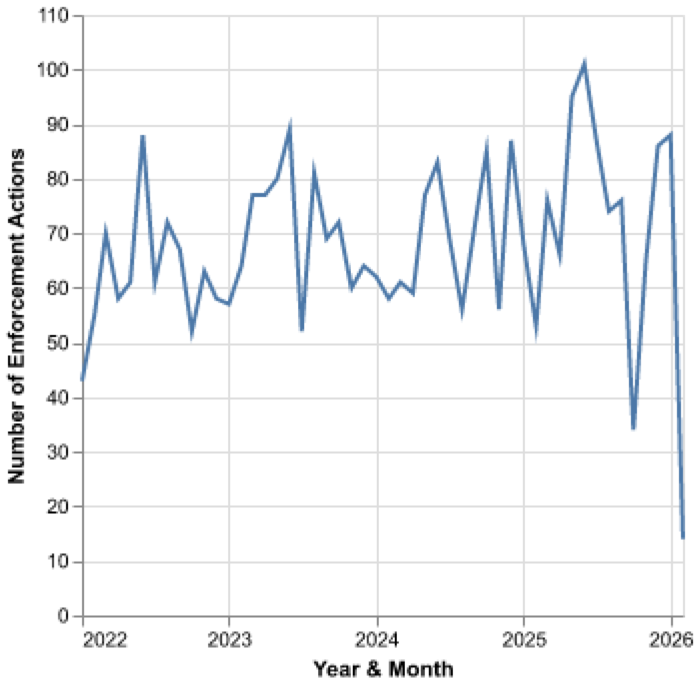
Step 3: Plot data based on scraped data

1. Plot the number of enforcement actions over time

```
df = pd.read_csv("enforcement_actions_2022_1.csv")
df['date'] = pd.to_datetime(df['date'])
df["year_month"] = df["date"].dt.to_period("M").dt.to_timestamp()

month_count = df.groupby("year_month").size().reset_index(name="num_actions")
```

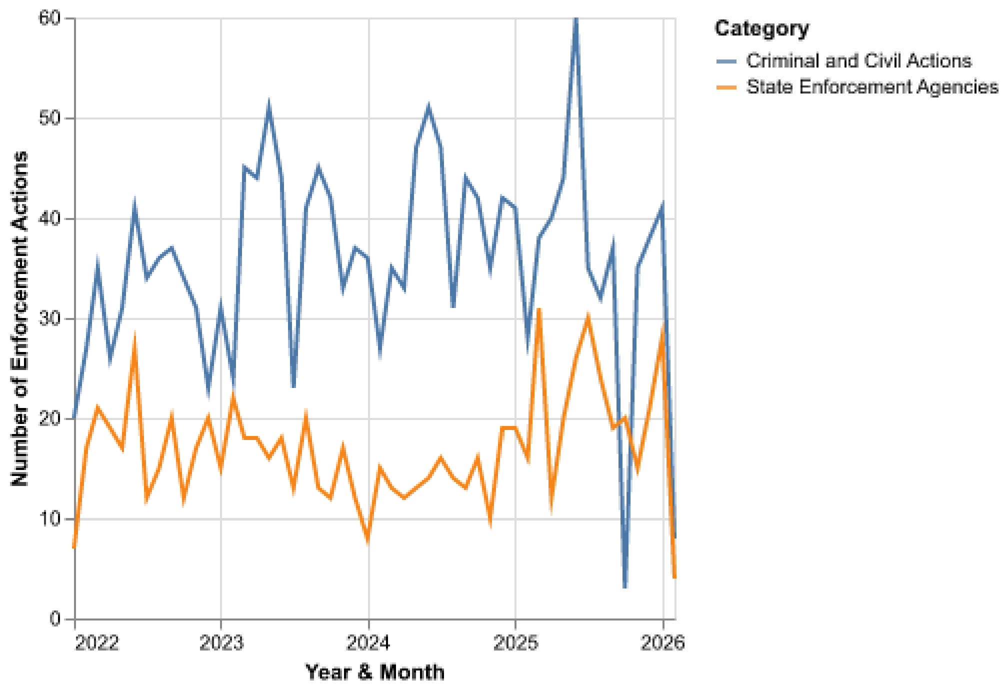
```
line1 = alt.Chart(month_count).mark_line().encode(
  alt.X("year_month:T", title="Year & Month"),
  alt.Y("num_actions:Q", title="Number of Enforcement Actions")
)
line1
```



2. Plot the number of enforcement actions categorized:

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

```
category_1 = df[df['category'].isin(['Criminal and Civil Actions', 'State
↪  Enforcement Agencies'])]
category_graph = category_1.groupby(['year_month',
↪  'category']).size().reset_index(name="num_actions")
line2 = alt.Chart(category_graph).mark_line().encode(
  alt.X("year_month:T", title="Year & Month"),
  alt.Y("num_actions:Q", title="Number of Enforcement Actions"),
  color = alt.Color('category:N', title='Category')
)
line2
```



- based on five topics

```
criminal = df[df["category"] == "Criminal and Civil Actions"].copy()
def classify_topic(title):
    t = title.lower()

    if any(k in t for k in [
        "medicare", "medicaid", "health", "hospital",
        "doctor", "physician", "clinic", "pharmacy"
    ]):
        return "Health Care Fraud"

    elif any(k in t for k in [
        "bank", "banker", "financial", "wire",
        "money laundering", "loan", "mortgage", "securities"
    ]):
        return "Financial Fraud"

    elif any(k in t for k in [
        "drug", "opioid", "fentanyl",
        "controlled substance", "prescription"
    ]):
        return "Drug Enforcement"
```

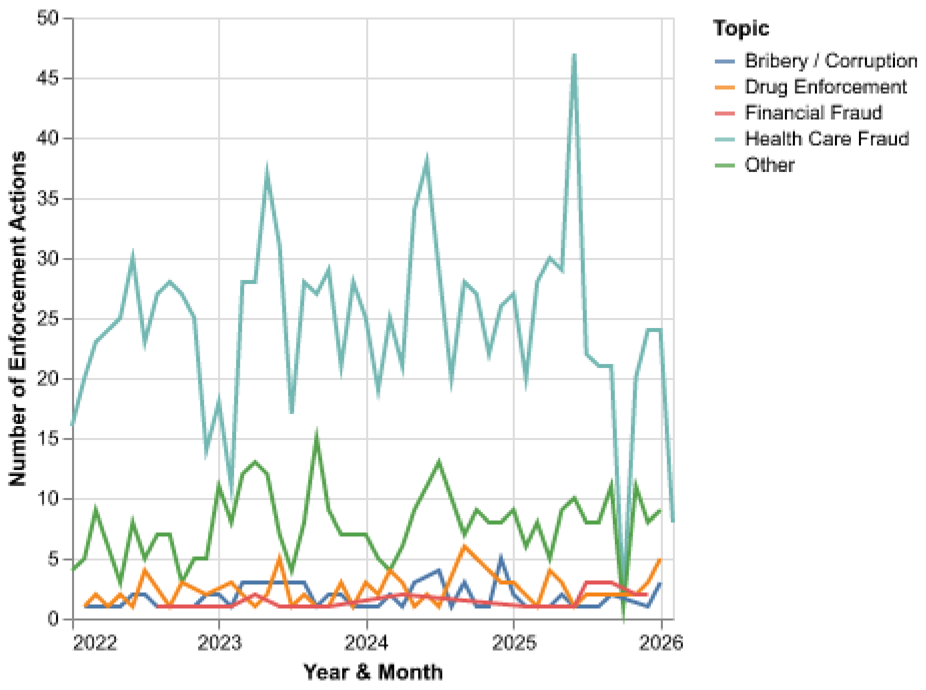
```python
    elif any(k in t for k in [
        "bribe", "bribery", "kickback",
        "corruption", "embezzle", "embezzlement"
    ]):
        return "Bribery / Corruption"

    else:
        return "Other"

criminal["topic"] = criminal["title"].apply(classify_topic)
topic_monthly = (
    criminal
    .groupby(["year_month", "topic"])
    .size()
    .reset_index(name="count")
)

line3 = (
    alt.Chart(topic_monthly)
    .mark_line()
    .encode(
        alt.X("year_month:T", title="Year & Month"),
        alt.Y("count:Q", title="Number of Enforcement Actions"),
        color=alt.Color("topic:N", title="Topic")
    )
)

line3
```


Number of Enforcement Actions
50
45
40
35
30
25
20
15
10
5
0
2022
2023
2024
2025
2026
Year & Month
Topic
Bribery / Corruption
Drug Enforcement
Financial Fraud
Health Care Fraud
Other