Bribing the way to Destruction: Exploring the Effect of Donations from Fossil Fuel Companies to Politicians on Greenhouse Gas Emissions

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Problem Description and Research Question

There is plenty of awareness that climate change is happening, and many studies have explored and demonstrated the impacts and effects between anthropogenic GHG emissions, fossil fuels, climate change, and natural disasters. However, it is not enough to observe this phenomenon – we must find out **who** causes GHG emissions, **who** causes climate change.

The USA and Australia are two of the biggest polluters and GHG emitters per capita in the world (Ritchie, 2016). Governments and politicians in these countries have consistently failed to implement rigorous climate policies. **Why is this?** A major part of the answer lies in massive monetary donations from fossil fuel companies to politicians and their campaigns (Goldenberg & Bengtsson 2016).

For example, in 2020, Chevron and Exxon significantly increased contributions to the US Democratic party, and at the same time Joe Biden has declared banning fossil fuels within a decade 'an impossibility' (Stancil, 2020). In other circumstances, politicians have granted tax subsidies, passed lax environmental laws, and given approvals for disastrous projects like the Adani Carmichael coal mine (Smee, 2020).

We need to go behind the curtain and expose the capitalist forces which threaten our future on this planet. Therefore, our research question is **how, and to what extent do donations from fossil fuel companies to politicians influence GHG emissions in the USA and Canada?**

Of course, the scope of this question and project cannot cover the underlying economic system that allows for the corruption in question. However, bringing this issue to light may help all of us realize how broken our capitalist-controlled governmental model is. Even in Canada *this year*, the Canadian Association of Petroleum Producers successfully lobbied the federal government to delay implementing the Clean Fuel Standard (Firempong, 2020). We as citizens need to hold the government and corporations responsible for their harmful actions that undermine both democracy and the future of our planet.

Dataset Description

Data on GHG emissions in total and per capita, segmented by country and year, will be sourced from the Our World in Data database (https://github.com/owid/co2-data, CC BY 4.0), in JSON format. From this JSON file, we have extracted the part with the "`iso_code`" of "`USA`". In this simplified json file, the values associated to the keys "`year`","`total_ghg`" and "`co2`" are used: `year` is used to identify and organize the processed data according to the years, `total_ghg` is mainly used to represent the amount of GHG emission in such year, and `co2` is used only when the key `total_ghg` is not present in the JSON file.

For donations in the USA, there are two main sources: data from the nonpartisan research group *Center for Responsive Politics* (opensecrets.org, CC BY-NC-SA 3.0), and the think tank *InfluenceMap* (influencemap.org, custom license with attribution). These contain multiple HTML tables with name of political candidates and donations by industry sector by year.

For donations in Canada, we have massive datasets from *The National Post* (special.nationalpost.com, Public Domain). There are 5 csv files containing hundreds of thousands of donors' data to the Canadian politicians. For the purpose of this project, we have filtered (using the fourth column of the csv files) some unnecessary datas so that the company name only includes one of the 10 main Oil & Gas companies in Canada:

- Suncor
- Canadian Natural Resources
- Imperial Oil
- Enbridge
- Transcanada Corps.
- Husky Energy
- Cenovus Energy
- Encana
- Talisman Energy
- Crescent Point Energy

For GHG emission data in Canada, we have used the dataset from the Government of Canada (open.canada.ca, Open Government License - Canada). It is a simple csv file containing the year and the amount of GHG emission in the given year.

Computational Overview

Data collection and processing

Firstly, we merge the data from the different sources within each country.

In the `data.py` file, we used the **requests** and **BeautifulSoup** packages to extract elements from HTML for the USA donation data. The corresponding python function on `data.py` is `get_donation_data_usa`, where the variable `data` contains the donation data extracted from the webpage. For the GHG emission data in USA, we used the **json** module to process the files line by line (`read_ghg_data_usa` on `data.py`). The loop in lines 82-88 searches for the matching year and uses a `break` statement to increase efficiency by returning as soon as a matching value is found.

For the Canada donations dataset, we filtered by the companies listed above, and also any company with 'Fuel' in its name [Lines 139-146] (see `read_donation_data_canada` in `data.py` for more information). We also used the **multiprocessing** module to read the 5 large files concurrently [Lines 254-271]. This reduced the time to read and process the Canada dataset from 14 seconds to 5 seconds on a 2013 quad-core processor. For the emission dataset in Canada, since the file was a simple CSV file, we used the **csv** module to process the file (in the similar manner as the GHG emission data in USA).

Visualization

We wanted our project to make an emotional impact on whoever views it, so we decided to have a visual and interactive experience to fully showcase our data and analysis. Thus, we decided to use Tkinter to make the GUI.

The files `Visualizer.py` and `Graph.py` carry out the visualization.

We planned to make a central "menu" which led to the other parts of the project (research question, graphs of data, analysis of data). We made mockup images of what the menu and graphing interface could look like, and used them as a guide when implementing the actual windowing and drawing code.

Mockup images created to give direction to our programming

In `Visualizer.py`, we use a Tkinter canvas for the main window. Tkinter's built-in canvas items don't have flexible blending options so we decided to use PIL images and Numpy arrays in conjunction with the Tkinter canvas:

1. Create PIL Images by reading the image files (jpg, png) using `Image.open(filename)` and if necessary, converting to RGBA mode [Lines 43-55]
2. Convert Images into Numpy arrays for faster and more flexible processing [Lines 43-55]
3. Use Numpy's special overridden array arithmetic operations to Add and Multiply the arrays together for some nice transparency and blending [Lines 91-99]. This is the core of our visual aspect and is implemented in the `Grapher.blend` function [Lines 271-293 in Graph.py].

   Using Numpy was crucial for both efficiency (over twice as fast as only PIL) and visual appearance (neither Tkinter or PIL have blending modes other than alpha).
4. Convert final Numpy array back into PIL Image/ImageTk [Lines 102-104]
5. Set the canvas's main image to the new frame [Lines 105-106]
6. Add extra Tkinter text elements (since PIL fonts are different across OS platforms) [Lines 110-119]
7. Check for user events - highlight a button if the mouse is over it, and execute an action if one is clicked [Lines 124-134, and 149-184].
8. Repeat steps 3-7! [Line 137]

The GUI runs at around 5-10 fps which is relatively low but still usable; we could have used OpenGL, Pygame, or similar libraries but decided that it was unnecessary and out of scope.

In `Graph.py`, we also use Tkinter and PIL to make an interactive plot / line graph of donations and emissions sharing the vertical axis, and time on the horizontal axis.

To create the line graph, we first transform all the points so that they are within the width and height of the window [Lines 195-210]. Then we use the `PIL.ImageDraw.Draw.line` function to draw the lines [Lines 213-214].

In `Plot.py`, we use Plotly to generate scatter graphs and show a linear regression line for our datasets.

Instructions

Install the Python packages: `requests beautifulsoup4 numpy Pillow`

There are 4 collections of data: donations and emissions for Canada and USA.

You can retrieve them and all the project files from `send.utoronto.ca` with codes:
Claim ID: `c5yKgHEEJHsifUah`
Claim Passcode: `j3KXEd9Pb6t7q89q`
Full URL:
`https://send.utoronto.ca/pickup.php?claimID=c5yKgHEEJHsifUah&claimPasscode=j3KXEd9Pb6t7q89q`

Alternatively:

- for the Canada emissions, download
  https://www.canada.ca/content/dam/eccc/documents/csv/cesindicators/ghg-emissions/2019/GHG-emissions-national-en.csv
  and save in a `csv/` subfolder
- for the Canada donations, you can download files from
  https://special.nationalpost.com/follow-the-money/database
  convert to csv and save in the `csv/` subfolder
- for the USA emissions, download
  https://github.com/owid/co2-data/raw/master/owid-co2-data.json
  and save in a `json/` subfolder
- The USA donation data is automatically gathered by the `data.py` file.

Running the program

Running the `main.py` file will create a borderless window that shows a menu similar to the mockup image on the previous page. Clicking on the Line Graph button will read and process the datasets (may take several seconds), then change the window to our line graphing interface as shown below.

You can mouse over the graph to see the years, and change between the Canada and USA datasets.

CSC2.PNG	CSC3.PNG

Screenshots of the line graph window

Clicking on the Scatter Graph button will read the data and open two Plotly graphs.

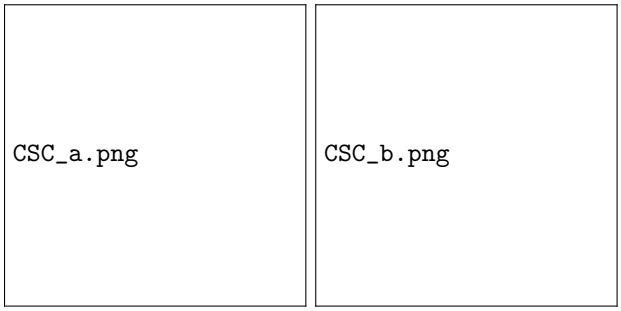
Changes

The overall feedback from the proposal was that we needed more data, and that the complexity may be a bit low. For the second point, we decided to skip using Plotly in favor of creating our own, more flexible UI with Tkinter, PIL, and Numpy.

Unfortunately, the data was just rather sparse, so we decided to go ahead with what we had and supplement it with a stronger visual and interactive aspect.

However, as we developed the visualization along with our analysis of the data, it became clear that neither the line graphs nor the scatter plots were showing any strong correlations. Combined with the difficulty of creating a flexible and stable GUI, we decided to leave out the unnecessary aspects of the visual interface like image annotations and the second set of scatter plots.

Discussion



From the graphs we obtained with Plotly together with the line graphs in our own GUI (see the Instructions section), there seems to be little to no correlation between donations and emissions in either Canada or the USA. We cannot give a definitive answer to our research question because there are too many factors which determine the amount of GHG emission each year; number of gasoline cars manufactured every year or even number of people deciding to take their cars instead of taking the public transit, which would increase the amount of GHG emission for such year without having the politicians receive a lot of donations. As another example, the drop in 2009 for the USA was probably caused by the global financial crisis at that time, and not because of any GHG regulations.

Public opposition to fossil fuel projects and subsidies likely play a role in limiting the effectiveness of corporate lobbying. For example, the divestment movement has recently found some success in the USA. Nationally in Canada, there have been several protests about climate changes, claiming that use of fossil fuels and carbon footprints are destroying our planet. These movements, whether they are big or small, effectively demonstrate that **the amount of donations politicians receive have almost no impact to the yearly GHG emissions.**

As of how our obstacles and the limitations were, the datasets available couldn't perfectly represent the correlation between the amount of donations politicians are receiving and the amount of GHG emissions (as mentioned in the Changes section). As we continued to develop the Python files for simple regression graph and the scatter plots, it has become almost certain that the datasets discovered didn't show any strong correlations for our initial research question.

These obstacles and limitations naturally translate to how we would take this as an initial step for the potential future projects: comparing how the amount of GHG emissions are changing, **considering major factors that we mentioned beforehand**. Of course, it is almost impossible to accurately predict future years' GHG emission with the trend of past years' external factors that determine the GHG emission (as of right now, it will probably require machine learning and/or artificial intelligence knowledge to develop a model that can take these raw datasets to produce accurate prediction). Although it may seem like an impossible task for now, with future learnings from upper year courses and our own experiment on this topic, we strongly believe that we can take this project to another level.

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