INTERACTIVE WORLD CARBON DIOXIDE EMISSION DASHBOARD

A PROJECT REPORT

By

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BONAFIDE CERTIFICATE

Certified that this minor project report for the course **21CSC203P ADVANCED PROGRAMMING PRACTICE** entitled in "Interactive World Carbon Dioxide Emission Dahboard" is the bonafide work of **Ananya Sharma(RA2211031010025) , Riya Rao (RA2211031010026)** who carried out the workunder my supervision.

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ABSTRACT

The Python Jupyter Notebook titled "World Carbon Dioxide Emission Dashboard Mini Project" is a data exploration and visualization tool developed using Pandas, NumPy, and Panel. Leveraging the capabilities of Pandas for efficient data manipulation and NumPy for numerical operations, the notebook provides a robust foundation for processing diverse datasets related to global carbon dioxide emissions. The inclusion of Panel enhances the user interface, allowing for interactive and customizable dashboards. The 'tabulator' extension in Panel contributes to the presentation of clear and organized tabular data, enriching the user experience. Additionally, the integration of Hvplot, a powerful library for interactive plotting with Bokeh, further enhances the visualization capabilities of the dashboard. By combining these libraries, the project offers a comprehensive solution for exploring and gaining insights into the complex landscape of worldwide carbon dioxide emissions.

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INTRODUCTION

In the face of escalating environmental concerns, the development of the "World Carbon Dioxide Emission Dashboard Mini Project" emerges as a crucial initiative. This project aims to provide a comprehensive and interactive platform for exploring and understanding global carbon dioxide emissions. Through the integration of cutting-edge technologies and data science methodologies, the dashboard endeavors to shed light on the intricate patterns and trends within carbon emission data, fostering informed decision-making and advocacy for a sustainable future.

1.1 Motivation

The motivation behind this project stems from the imperative need to address the escalating challenges posed by climate change and environmental degradation. By creating an accessible and insightful dashboard, the project seeks to empower researchers, policymakers, and the public with the tools necessary to comprehend the complexities of carbon emissions on a global scale.

1.2 Objective

The primary objective of the "World Carbon Dioxide Emission Dashboard Mini Project" is to develop a user-friendly and interactive platform that allows users to explore, analyze, and visualize carbon dioxide emission data comprehensively. The project aims to facilitate a nuanced understanding of temporal trends, regional disparities, and sector-specific contributions to carbon output.

1.3 Problem Statement

The lack of accessible and comprehensive tools for exploring and analyzing carbon dioxide emission data poses a significant challenge in addressing environmental concerns. This project aims to bridge this gap by providing a solution that not only processes and presents data efficiently but also encourages user engagement and exploration.

1.4 Challenges

The development of the dashboard is not without its challenges. Ensuring data security, implementing effective encryption protocols, and optimizing performance to handle large-scale datasets are among the challenges that the project team anticipates. Overcoming these challenges will contribute to the creation of a robust and impactful tool for understanding and addressing global carbon dioxide emissions.

CONTENT

1. Data Ethics and Privacy

In the contemporary digital landscape, where data is a currency and privacy is paramount, ethical considerations surrounding data use are of utmost importance. This project, focused on CO2 emissions, relies on publicly available data that does not involve any personal or sensitive information, mitigating privacy concerns. However, ethical data use encompasses more than just privacy concerns.

The data utilized in this project is collected and maintained by various global organizations, exerting significant effort to ensure accuracy and reliability. As conscientious data users, it is imperative to respect these endeavors. Responsible data use entails acknowledging the source of the data and ensuring it is not misrepresented or taken out of context. Additionally, during data analysis and visualization, care has been taken to guarantee fair and unbiased interpretations, offering an accurate representation of the data.

2. Future Work and Extensions

While the current project offers a comprehensive overview of global CO2 emissions, there is ample room for enhancement and expansion in future iterations. Considerations for future work include the incorporation of more granular data, such as emissions at the city or industry level. This could yield more nuanced insights, aiding in the identification of specific areas or sectors where emission reduction efforts could be strategically targeted.

Further improvements could involve introducing more interactive features to the dashboard, such as predictive models forecasting future emission trends based on historical data. This would empower users not only to comprehend past and present emissions but also to gain insights into potential future scenarios. Integration of additional data sources could also be explored to analyze the correlation between CO2 emissions and other factors like economic growth, energy consumption, and deforestation. This holistic approach would provide a more comprehensive understanding of the myriad factors influencing CO2 emissions.

3. User Guide

Our CO2 emissions dashboard is meticulously crafted to be user-friendly and intuitive, catering to a diverse audience, whether technically inclined or not. The sidebar offers a concise introduction to CO2 emissions and climate change, accompanied by a settings panel that allows users to customize the data view. This feature empowers users to tailor the dashboard to their specific interests and analytical needs.

The central area of the dashboard hosts a series of interactive plots and tables presenting CO2 emissions data. Each plot and table is thoughtfully designed to present data in a clear and understandable manner. Interacting with the plots is seamless—hovering over data points provides detailed information, enhancing the engagement and informativeness of the data exploration process. The tables offer a tabular view of the data, enabling users to sort and filter rows based on different criteria. This functionality allows users to focus on specific aspects of the data that pique their interest.

This user guide is intended to enhance your experience with our dashboard, aiding you in uncovering meaningful insights about global CO2 emissions. We firmly believe that with the right tools, everyone can contribute to global efforts to mitigate climate change.

LITERATURE SURVEY

The importance of monitoring and analyzing carbon dioxide (CO2) emissions has been recognized by the scientific community due to its significant impact on climate change. Various projects have been developed to track, visualize, and analyze CO2 emissions using Python and Jupyter notebooks.

Existing Projects

1. **Our World in Data's CO2 Data Repository**1: This repository provides data on CO2 and greenhouse gas emissions. It is updated regularly and can be used as a reliable source of emission data.
2. **Eco2AI**1: This Python library accumulates statistics about power consumption and CO2 emissions during code execution. It can be used to measure the environmental impact of running specific pieces of code.
3. **Forestatrisk**1: This Python package models and forecasts the risk of deforestation, which is a significant contributor to CO2 emissions.
4. **Carbon Footprint Calculation**1: This project allows users to calculate their carbon footprint easily using a command line interface. It includes over 10 metrics and provides a PDF report.
5. **World CO2 Emissions Exploratory Data Analysis**23: This project uses Python for exploratory data analysis and visualization of world CO2 emissions based on 2016 data.
6. **Exploring CO2 Emission Data**4: This project uses Python and Pandas to clean, explore, summarize, and visualize world bank CO2 emission data.
7. **CO2 Emissions Project**5: This project used Python and Jupyter Notebook to analyze and visualize carbon emissions data, uncovering insights to aid climate change mitigation. Data from diverse sources informed strategies for reducing emissions and promoting sustainability.
8. **Sustainable Mobility API**1: This Python library and API calculate CO2 emissions for personal mobility, contributing to the understanding of transportation's impact on CO2 emissions.
9. **CO2 Emissions Prediction Countries**1: A machine learning project aiming to analyze and predict CO2 emissions from country parameters such as economic indicators, population, energy use, land use, etc., provided by the World Bank.
10. **Data Analysis and Visualization of CO2 Emission by Different Countries**6: This article provides an analysis over CO2 emission by different countries across the world.

REQUIREMENTS

1. Hardware Requirements:

- Robust server with ample processing, memory, and storage.
- Networking hardware: routers, switches.
- End-user devices: PCs.

2. Software Requirements:

- Python, Pandas, NumPy, Panel, Hvplot.
- Jupyter Notebooks.

3. Security and Privacy:

- Access control.
- Encryption protocols, HTTPS.

4. Interactive Visualization:

- User customization.
- Compatibility with modern web browsers.

5. Data Integration and Compatibility:

- Seamless integration of diverse datasets.
- Compatibility with various data formats and sources.

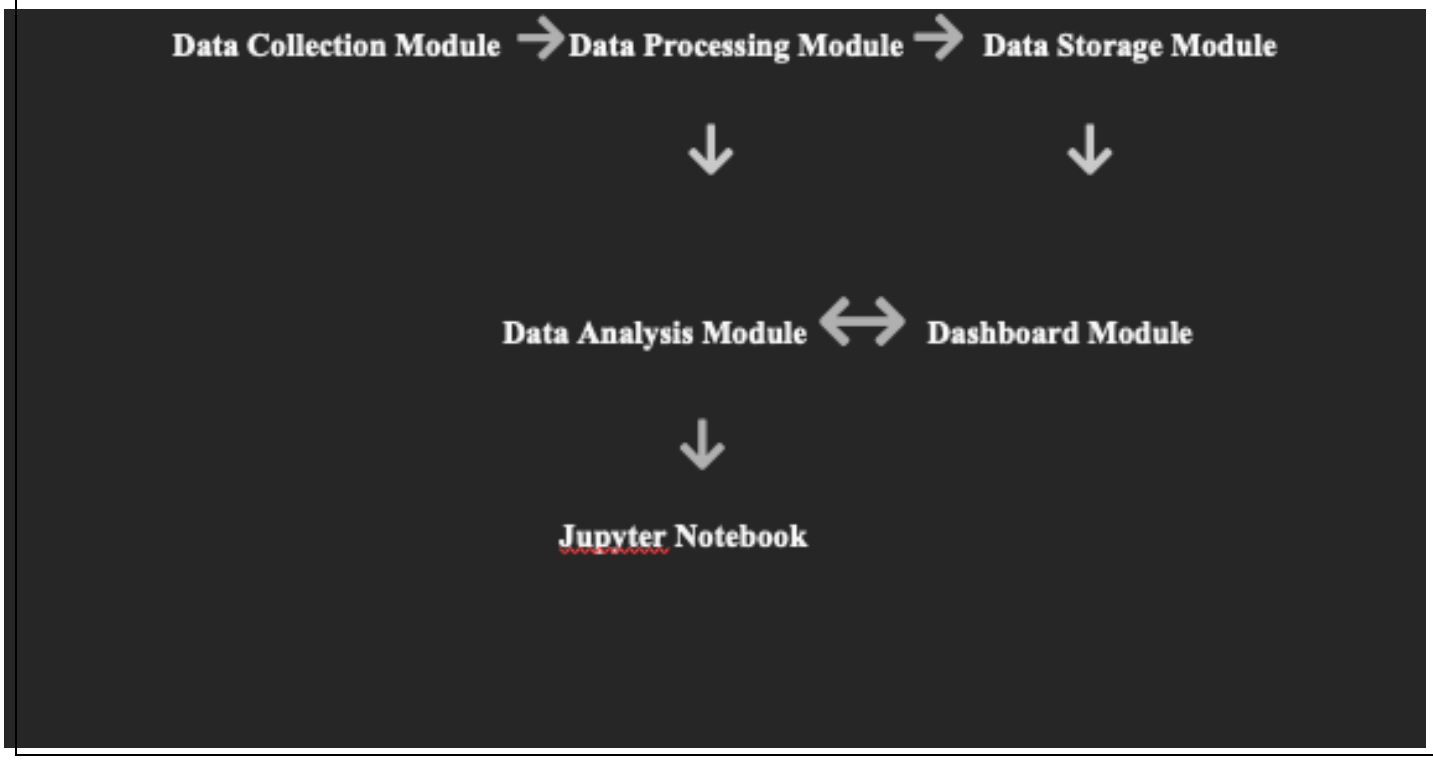
6. Scalability and Performance:

- Scalability.
- Performance testing and optimization

5. ARCHITECTURE AND DESIGN

4.1 Network Architecture

1. Data Collection Module: This module is responsible for collecting the CO2 emissions data. It can use APIs or web scraping techniques to gather data from reliable sources such as Our World in Data's CO2 Data Repository.
2. Data Processing Module: This module will clean and preprocess the collected data. It will handle missing values, outliers, and data transformation. This module can use Python libraries such as Pandas and NumPy.
3. Data Storage Module: This module will store the processed data. It can use a simple file system or a database system for storage.
4. Data Analysis Module: This module will perform exploratory data analysis on the stored data. It can use Python libraries such as Pandas, Matplotlib, and Seaborn for this purpose.
5. Dashboard Module: This module will create interactive dashboards to visualize the CO2 emissions data. It can use Python libraries such as Plotly and Dash for creating the dashboards.
6. Jupyter Notebook: The Jupyter notebook will serve as the interface for the entire project. It will contain the code for all the modules and will present the results in an interactive and user-friendly manner.



6. SOURCE CODE

```
import pandas as pd

import numpy as np

import panel as pn

pn.extension('tabulator')

import hvplot.pandas


if 'data' not in pn.state.cache.keys():


    df = pd.read_csv('https://raw.githubusercontent.com/owid/co2-data/master/owid-co2-data.csv')


    pn.state.cache['data'] = df.copy()


else:


    df = pn.state.cache['data']


df.columns

df[df['country'] == 'North America']


df = df.fillna(0)

df['gdp_per_capita'] = np.where(df['population']!= 0, df['gdp']/ df['population'], 0)


idf = df.interactive()
```

```
# Define Panel widgets
year_slider = pn.widgets.IntSlider(name='Year slider', start=1750, end=2020, step=5, value=1850)
year_slider
# Radio buttons for CO2 measures
yaxis_co2 = pn.widgets.RadioButtonGroup(
    name='Y axis',
    options=['co2', 'co2_per_capita',],
    button_type='success'
)
# Radio buttons for CO2 measures
yaxis_co2 = pn.widgets.RadioButtonGroup(
    name='Y axis',
    options=['co2', 'co2_per_capita',],
    button_type='success'
)
continents = ['World', 'Asia', 'Oceania', 'Europe', 'Africa', 'North America', 'South America',
'Antarctica']


co2_pipeline = (
    idf[
        (idf.year <= year_slider) &
        (idf.country.isin(continents))
    ]
    .groupby(['country', 'year'])[yaxis_co2].mean()
```

```
    .to_frame()
    .reset_index()
    .sort_values(by='year')
    .reset_index(drop=True)
)
co2_pipeline
co2_plot = co2_pipeline.hvplot(x = 'year', by='country', y=yaxis_co2,line_width=2, title="CO2
emission by continent")
co2_plot
co2_table = co2_pipeline.pipe(pn.widgets.Tabulator, pagination='remote', page_size = 10,
sizing_mode='stretch_width')
co2_table
co2_vs_gdp_scatterplot_pipeline = (
    idf[
        (idf.year == year_slider) &
        (~ (idf.country.isin(continents)))
    ]
    .groupby(['country', 'year', 'gdp_per_capita'])['co2'].mean()
    .to_frame()
    .reset_index()
    .sort_values(by='year')
    .reset_index(drop=True)
)

co2_vs_gdp_scatterplot_pipeline
```

```
co2_vs_gdp_scatterplot = co2_vs_gdp_scatterplot_pipeline.hvplot(x='gdp_per_capita',
                                                y='co2',
                                                by='country',
                                                size=80, kind="scatter",
                                                alpha=0.7,
                                                legend=False,
                                                height=500,
                                                width=500)
co2_vs_gdp_scatterplot



yaxis_co2_source = pn.widgets.RadioButtonGroup(
    name='Y axis',
    options=['coal_co2', 'oil_co2', 'gas_co2'],
    button_type='success'
)

continents_excl_world = ['Asia', 'Oceania', 'Europe', 'Africa', 'North America', 'South America',
'Antarctica']

co2_source_bar_pipeline = (
    idf[
        (idf.year == year_slider) &
        (idf.country.isin(continents_excl_world))
    ]
    .groupby(['year', 'country'])[yaxis_co2_source].sum()
    .to_frame()
    .reset_index()
    .sort_values(by='year')
    .reset_index(drop=True)

)
```

```
co2_source_bar_plot = co2_source_bar_pipeline.hvplot(kind='bar',
                                        x='country',
                                        y=yaxis_co2_source,
                                        title='CO2 source by continent')
co2_source_bar_plot

#Layout using Template
template = pn.template.FastListTemplate(
   title='World CO2 emission dashboard',
   sidebar=[pn.pane.Markdown("# CO2 Emissions and Climate Change"),
           pn.pane.Markdown("#### Carbon dioxide emissions are the primary driver of global climate change. It’s widely recognised that to avoid the worst impacts of climate change, the world needs to urgently reduce emissions. But, how this responsibility is shared between regions, countries, and individuals has been an endless point of contention in international discussions."),
           pn.pane.PNG('climate_day.png', sizing_mode='scale_both'),
           pn.pane.Markdown("## Settings"),
           year_slider],
   main=[pn.Row(pn.Column(yaxis_co2,
                          co2_plot.panel(width=700), margin=(0,25)),
                co2_table.panel(width=500)),
         pn.Row(pn.Column(co2_vs_gdp_scatterplot.panel(width=600), margin=(0,25)),
                pn.Column(yaxis_co2_source, co2_source_bar_plot.panel(width=600)))],
   accent_base_color="#88d8b0",
   header_background="#88d8b0",
)
# template.show()
template.servable();
```

7. OUTPUT

Index(['country', 'year', 'iso_code', 'population', 'gdp', 'cement_co2',
'cement_co2_per_capita', 'co2', 'co2_growth_abs', 'co2_growth_prct',
'co2_including_luc', 'co2_including_luc_growth_abs',
'co2_including_luc_growth_prct', 'co2_including_luc_per_capita',
'co2_including_luc_per_gdp', 'co2_including_luc_per_unit_energy',
'co2_per_capita', 'co2_per_gdp', 'co2_per_unit_energy', 'coal_co2',
'coal_co2_per_capita', 'consumption_co2', 'consumption_co2_per_capita',
'consumption_co2_per_gdp', 'cumulative_cement_co2', 'cumulative_co2',
'cumulative_co2_including_luc', 'cumulative_coal_co2',
'cumulative_flaring_co2', 'cumulative_gas_co2', 'cumulative_luc_co2',
'cumulative_oil_co2', 'cumulative_other_co2', 'energy_per_capita',
'energy_per_gdp', 'flaring_co2', 'flaring_co2_per_capita', 'gas_co2',
'gas_co2_per_capita', 'ghg_excluding_lucf_per_capita', 'ghg_per_capita',
'land_use_change_co2', 'land_use_change_co2_per_capita', 'methane',
'methane_per_capita', 'nitrous_oxide', 'nitrous_oxide_per_capita',
'oil_co2', 'oil_co2_per_capita', 'other_co2_per_capita',
'other_industry_co2', 'primary_energy_consumption',
'share_global_cement_co2', 'share_global_co2',
'share_global_co2_including_luc', 'share_global_coal_co2',
'share_global_cumulative_cement_co2', 'share_global_cumulative_co2',
'share_global_cumulative_co2_including_luc',
'share_global_cumulative_coal_co2',
'share_global_cumulative_flaring_co2',
'share_global_cumulative_gas_co2', 'share_global_cumulative_luc_co2',
'share_global_cumulative_oil_co2', 'share_global_cumulative_other_co2',

```
 'share_global_flaring_co2', 'share_global_gas_co2',
 'share_global_luc_co2', 'share_global_oil_co2',
 'share_global_other_co2', 'share_of_temperature_change_from_ghg',
 'temperature_change_from_ch4', 'temperature_change_from_co2',
 'temperature_change_from_ghg', 'temperature_change_from_n2o',
 'total_ghg', 'total_ghg_excluding_lucf', 'trade_co2',
 'trade_co2_share'],
dtype='object')
```

ge_from_ghg	temperature_change_from_ch4	temperature_change_from_co2	temperature_change_from_ghg	temperature_change_from_n2o	total_ghg	total_ghg_excluding_lucf	trade_co2	trade_co2_share
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...
100.0	0.394	1.039	1.511	0.078	48251.879	47031.820	0.004	0.0
100.0	0.399	1.058	1.536	0.079	49368.039	47980.469	-0.004	-0.0
100.0	0.404	1.076	1.561	0.081	49758.230	48116.559	0.000	0.0
100.0	0.410	1.094	1.585	0.082	NaN	NaN	0.000	0.0
100.0	0.415	1.113	1.611	0.083	NaN	NaN	0.000	0.0

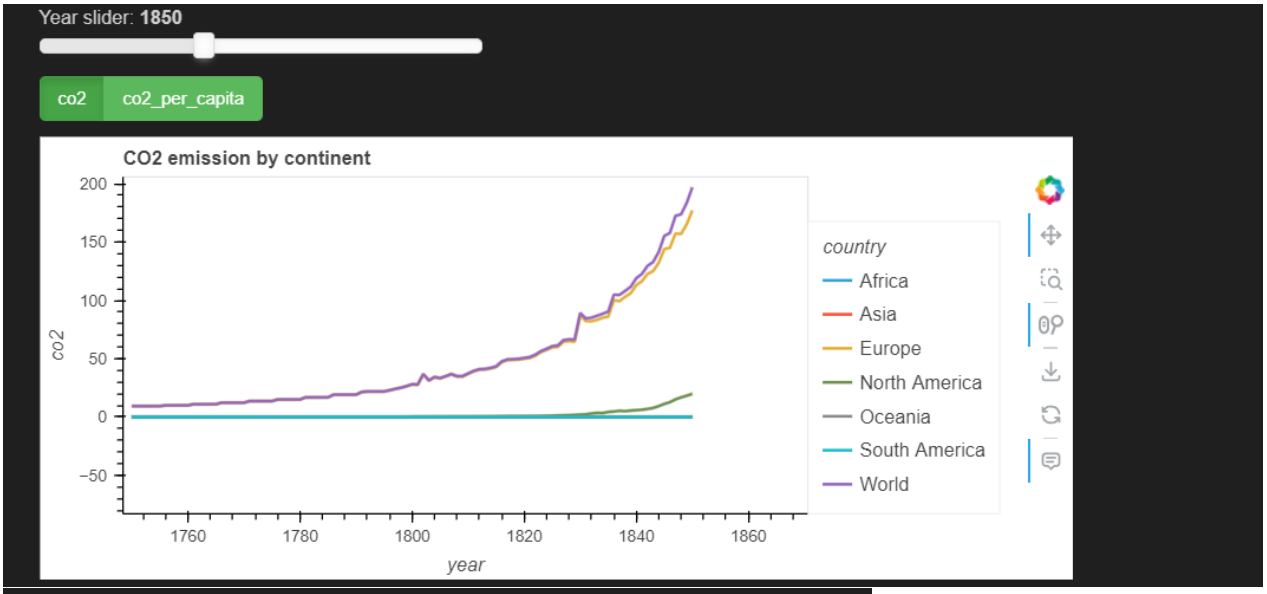
ge_from_ghg	temperature_change_from_ch4	temperature_change_from_co2	temperature_change_from_ghg	temperature_change_from_n2o	total_ghg	total_ghg_excluding_lucf	trade_co2	trade_co2_share
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...
22.462	0.052	0.273	0.339	0.014	7418.35	7566.229	386.995	6.023
22.313	0.053	0.276	0.343	0.015	7630.50	7777.590	388.395	5.872
22.162	0.053	0.279	0.346	0.015	7515.65	7663.030	382.097	5.878
22.009	0.053	0.281	0.349	0.015	NaN	NaN	450.023	7.752
21.858	0.053	0.284	0.352	0.015	NaN	NaN	NaN	NaN

	country	year	iso_code	population	gdp	cement_co2	cement_co2_per_capita	co2	co2_growth_abs	co2_growth_prct	...	share_global_other_co2	share_of_temperature_change_from_gh
33337	North America	1750	NaN	11396206.0	NaN	0.000	0.000	0.000	NaN	NaN	...	NaN	Na
33338	North America	1751	NaN	NaN	NaN	0.000	NaN	0.000	0.000	NaN	...	NaN	Na
33339	North America	1752	NaN	NaN	NaN	0.000	NaN	0.000	0.000	NaN	...	NaN	Na
33340	North America	1753	NaN	NaN	NaN	0.000	NaN	0.000	0.000	NaN	...	NaN	Na
33341	North America	1754	NaN	NaN	NaN	0.000	NaN	0.000	0.000	NaN	...	NaN	Na
...	...	...	...	...	...	...	...	...	...	...	...	...	
33604	North America	2017	NaN	581258143.0	NaN	75.813	0.131	6425.781	-47.450	-0.733	...	9.941	22.46
33605	North America	2018	NaN	585864285.0	NaN	74.562	0.127	6614.565	188.784	2.938	...	8.880	22.31
33606	North America	2019	NaN	590497015.0	NaN	75.227	0.127	6500.850	-113.715	-1.719	...	9.281	22.16
33607	North America	2020	NaN	594263186.0	NaN	75.718	0.127	5805.619	-695.230	-10.694	...	9.241	22.00
33608	North America	2021	NaN	597123384.0	NaN	77.944	0.131	6137.900	332.281	5.723	...	9.246	21.85

272 rows × 79 columns

681	World	1847	172.402
682	Oceania	1847	0.000
683	Europe	1847	157.299
684	Africa	1847	0.000
685	South America	1847	0.000
686	World	1848	173.816
687	Asia	1848	0.000
688	Africa	1848	0.000
689	North America	1848	16.825
690	Europe	1848	156.991
691	South America	1848	0.000
692	Oceania	1848	0.000
693	World	1849	183.511
694	North America	1849	18.269
695	Oceania	1849	0.000
696	Africa	1849	0.000
697	South America	1849	0.000
698	Europe	1849	165.243
699	Asia	1849	0.000
700	Asia	1850	0.015
701	Oceania	1850	0.000
702	North America	1850	19.852
703	Africa	1850	0.000
704	South America	1850	0.000
705	Europe	1850	177.030
706	World	1850	196.896

	country	year	co2
0	Africa	1750	0.000
1	North America	1750	0.000
2	South America	1750	0.000
3	Asia	1750	0.000
4	World	1750	9.351
5	Europe	1750	9.351
6	Oceania	1750	0.000
7	Africa	1751	0.000
8	Europe	1751	9.351
9	Asia	1751	0.000
10	World	1751	9.351
11	South America	1751	0.000
12	Oceania	1751	0.000
13	North America	1751	0.000
14	World	1752	9.354
15	South America	1752	0.000
16	Asia	1752	0.000
17	Europe	1752	9.354
18	North America	1752	0.000
19	Africa	1752	0.000
20	Oceania	1752	0.000
21	Asia	1753	0.000
22	North America	1753	0.000
23	Oceania	1753	0.000
24	Europe	1753	9.354
25	South America	1753	0.000
26	World	1753	9.354
27	Africa	1753	0.000
28	South America	1754	0.000
29	Africa	1754	0.000
30	Oceania	1754	0.000
31	North America	1754	0.000
32	Asia	1754	0.000
33	World	1754	9.358
34	Europe	1754	9.358
35	Europe	1755	9.362
36	North America	1755	0.000
37	Africa	1755	0.000
38	Oceania	1755	0.000
39	South America	1755	0.000
40	World	1755	9.362
41	Asia	1755	0.000
42	North America	1756	0.000
43	World	1756	10.006
44	Oceania	1756	0.000
45	Asia	1756	0.000
46	Europe	1756	10.006
47	South America	1756	0.000
48	Africa	1756	0.000
49	Asia	1757	0.000
...	...	...	...
657	Europe	1843	125.085
658	South America	1844	0.000
659	Asia	1844	0.000
660	Europe	1844	132.113
661	Oceania	1844	0.000
662	World	1844	141.423
663	Africa	1844	0.000
664	North America	1844	9.310
665	Asia	1845	0.000
666	Europe	1845	144.003
667	Oceania	1845	0.000
668	North America	1845	11.208
669	World	1845	155.211
670	South America	1845	0.000
671	Africa	1845	0.000
672	Oceania	1846	0.000
673	South America	1846	0.000
674	North America	1846	12.736
675	World	1846	157.794
676	Europe	1846	145.058
677	Africa	1846	0.000



Year slider: **1850**

co2 co2_per_capita

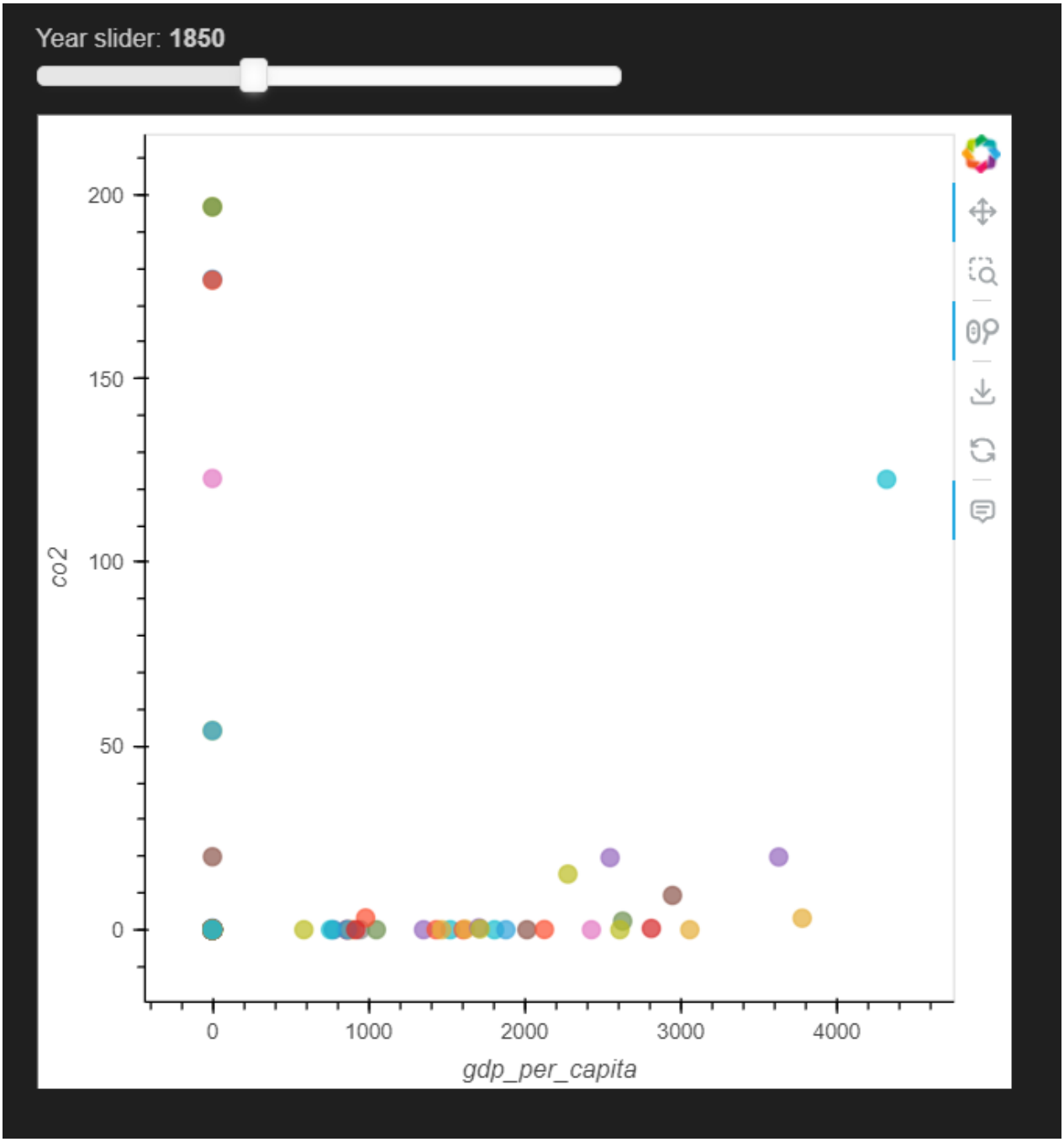
index	country	year	co2
0	Africa	1,750	0.0
1	North America	1,750	0.0
2	South America	1,750	0.0
3	Asia	1,750	0.0
4	World	1,750	9.351
5	Europe	1,750	9.351
6	Oceania	1,750	0.0
7	Africa	1,751	0.0
8	Europe	1,751	9.351
9	Asia	1,751	0.0

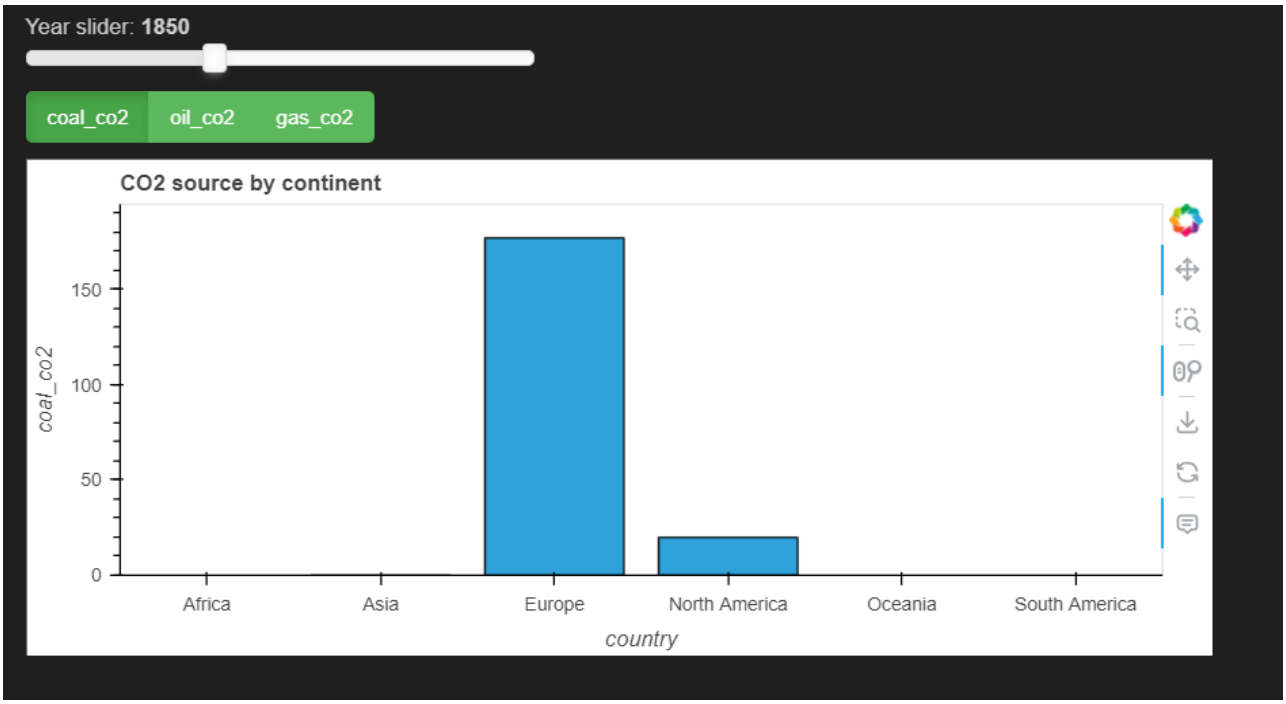
Year slider: **1850**

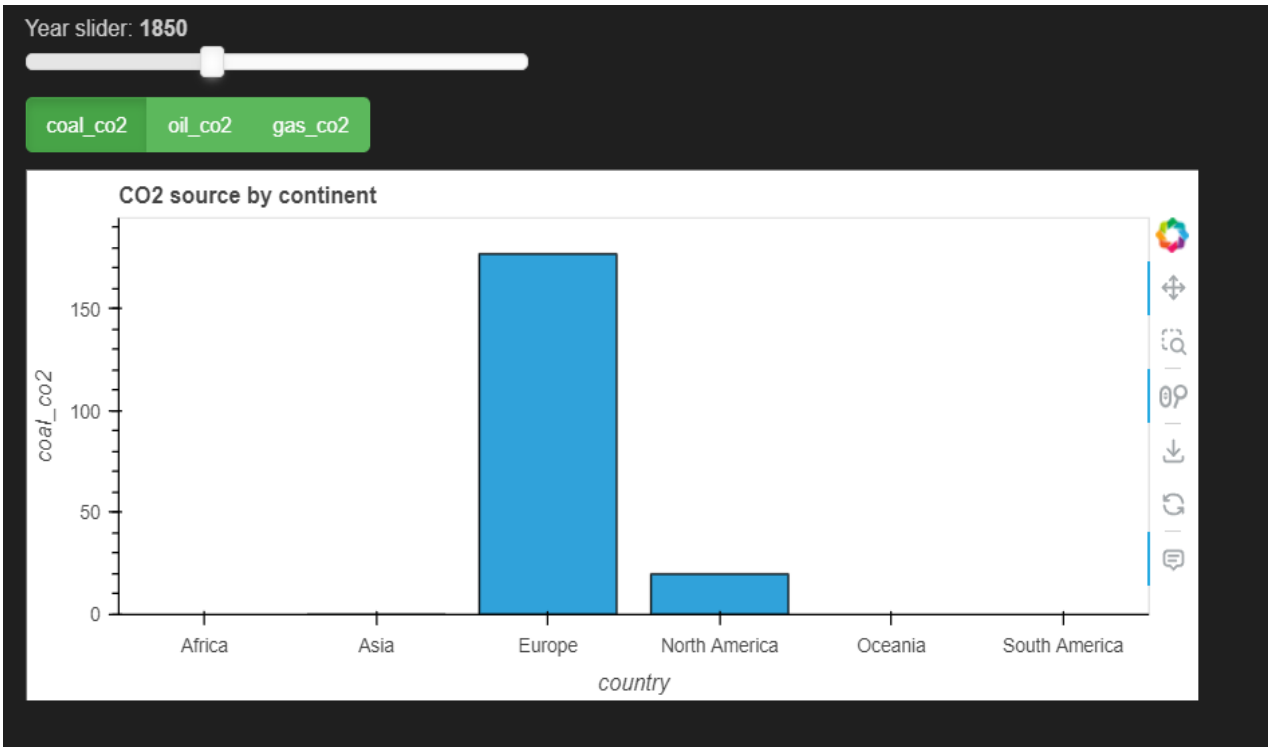
	country	year	gdp_per_capita	co2
0	Afghanistan	1850	0.000000	0.000
1	New Caledonia	1850	0.000000	0.000
2	New Zealand	1850	1807.790148	0.000
3	Nicaragua	1850	0.000000	0.000
4	Niger	1850	0.000000	0.000
5	Nigeria	1850	0.000000	0.000
6	Non-OECD (GCP)	1850	0.000000	0.112
7	North America (GCP)	1850	0.000000	19.852
8	North America (excl. USA)	1850	0.000000	0.059
9	North Korea	1850	0.000000	0.000
10	North Macedonia	1850	0.000000	0.000
11	Norway	1850	1620.608579	0.139
12	OECD (GCP)	1850	0.000000	196.784
13	Oceania (GCP)	1850	0.000000	0.000
14	Oman	1850	0.000000	0.000
15	Pakistan	1850	0.000000	0.000
16	Palestine	1850	0.000000	0.000
17	Panama	1850	0.000000	0.000
18	Papua New Guinea	1850	0.000000	0.000
19	Paraguay	1850	0.000000	0.000
20	Peru	1850	585.953994	0.000
21	Philippines	1850	0.000000	0.000
22	Poland	1850	981.556639	3.202

48	Moldova	1850	0.000000	0.001
49	Mongolia	1850	0.000000	0.000
...	...	...	...	...
184	Hong Kong	1850	0.000000	0.000
185	Hungary	1850	0.000000	0.000
186	Iceland	1850	0.000000	0.000
187	India	1850	947.271421	0.000
188	Indonesia	1850	756.867833	0.000
189	Iran	1850	0.000000	0.000
190	Iraq	1850	0.000000	0.000
191	Ireland	1850	0.000000	0.396
192	Isle of Man	1850	0.000000	0.000
193	Israel	1850	0.000000	0.000
194	Italy	1850	2611.209042	0.000
195	Jamaica	1850	864.691968	0.000
196	Japan	1850	1433.743020	0.000
197	Jersey	1850	0.000000	0.000
198	Jordan	1850	0.000000	0.000
199	Kazakhstan	1850	0.000000	0.008
200	Kenya	1850	0.000000	0.000
201	Kuwait	1850	0.000000	0.000
202	Guatemala	1850	0.000000	0.000
203	Guadeloupe	1850	0.000000	0.000
204	Grenada	1850	0.000000	0.000
205	Greenland	1850	0.000000	0.000
206	Ecuador	1850	0.000000	0.000
207	Egypt	1850	0.000000	0.000

208	El Salvador	1850	0.000000	0.000
209	Equatorial Guinea	1850	0.000000	0.000
210	Eritrea	1850	0.000000	0.000
211	Estonia	1850	0.000000	0.001
212	Eswatini	1850	0.000000	0.000
213	Ethiopia	1850	0.000000	0.000
214	Europe (GCP)	1850	0.000000	177.030
215	Europe (excl. EU-27)	1850	0.000000	122.840
216	Europe (excl. EU-28)	1850	0.000000	0.235
217	European Union (27)	1850	0.000000	54.190
218	Dominican Republic	1850	0.000000	0.000
219	European Union (27) (GCP)	1850	0.000000	54.190
220	Falkland Islands	1850	0.000000	0.000
221	Faroe Islands	1850	0.000000	0.000
222	Fiji	1850	0.000000	0.000
223	Finland	1850	1524.033676	0.000
224	France	1850	2548.249726	19.617
225	French Guiana	1850	0.000000	0.000
226	Gabon	1850	0.000000	0.000
227	Gambia	1850	0.000000	0.000
228	Georgia	1850	0.000000	0.000
229	Germany	1850	2277.899148	15.140
230	Ghana	1850	0.000000	0.000
231	Greece	1850	1606.884361	0.000
232	European Union (28)	1850	0.000000	176.795
233	Zimbabwe	1850	0.000000	0.000


Year slider: 1850
200
150
100
50
0
co2
0
1000
2000
3000
4000
gdp_per_capita

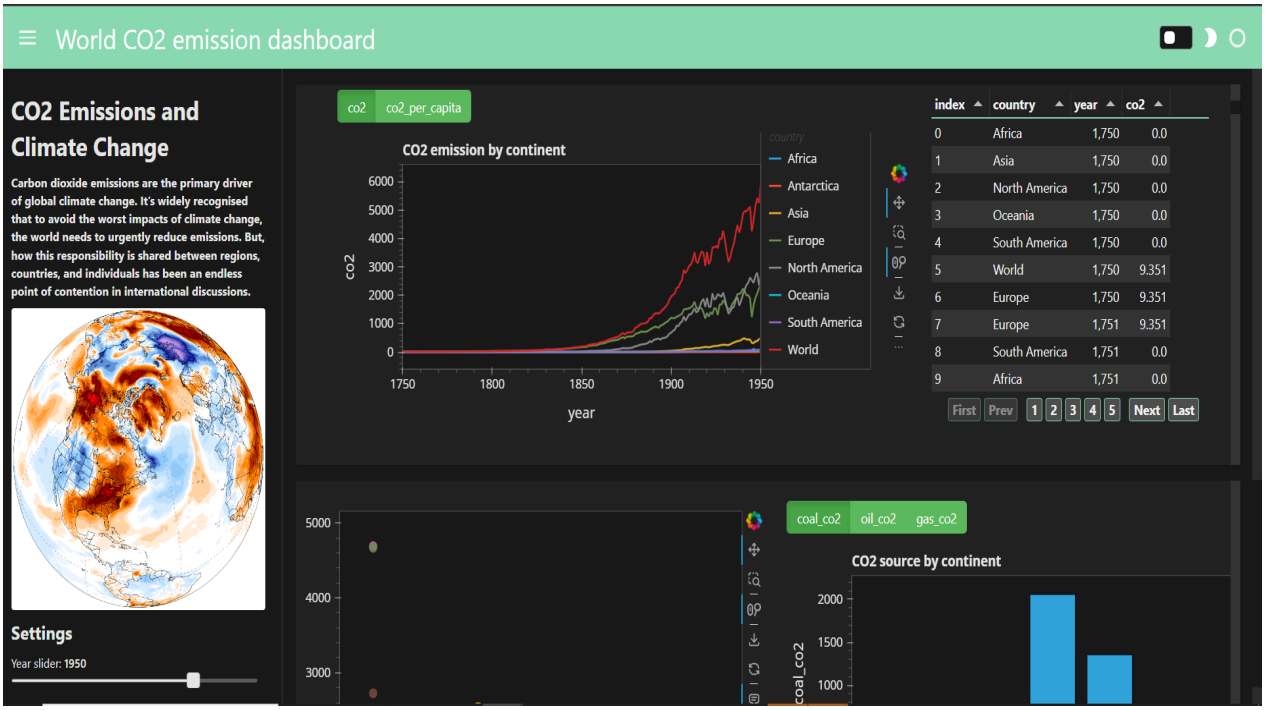

Year slider: 1850
coal_co2
oil_co2
gas_co2
CO2 source by continent
150
100
50
0
coal_co2
Africa
Asia
Europe
North America
Oceania
South America
country

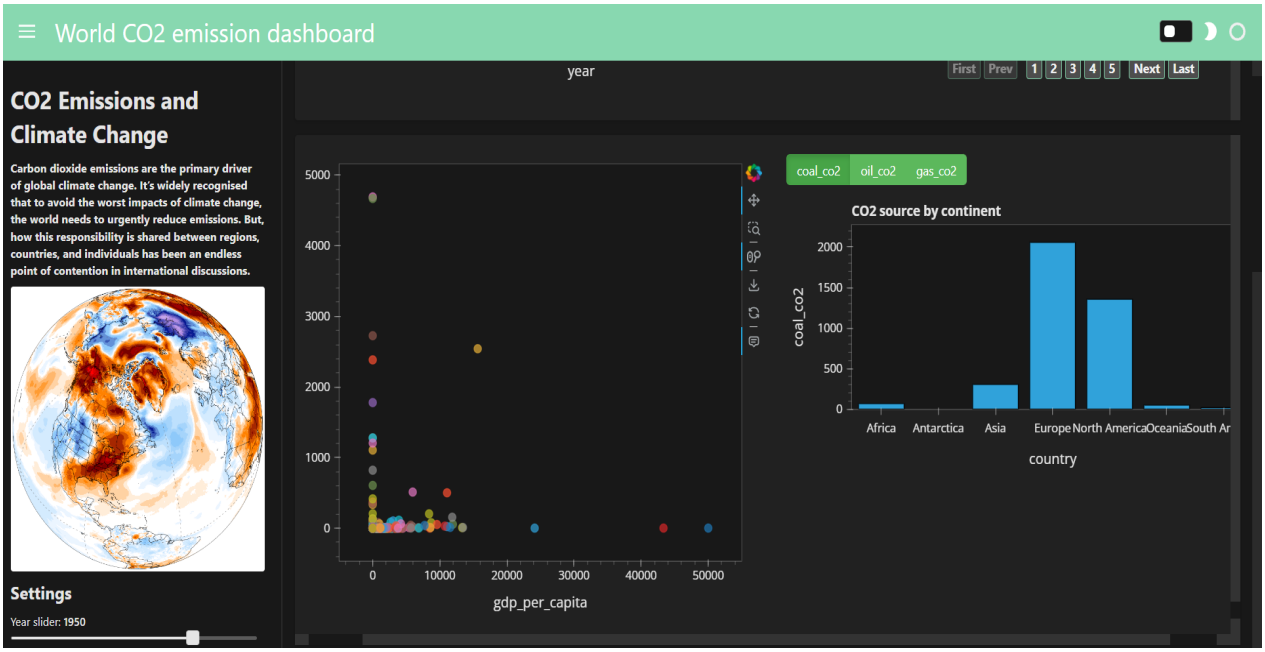

Year slider: 1850
coal_co2
oil_co2
gas_co2
CO2 source by continent
150
100
50
0
coal_co2
Africa
Asia
Europe
North America
Oceania
South America
country

8. IMPLEMENTATION

Component	Description	Python Libraries/Tools
Data Collection	Collects CO2 emissions data from reliable sources	pandas (pd)
Data Processing	Cleans and preprocesses the collected data	pandas (pd), numpy (np)
Data Storage	Stores the processed data	pandas (pd)
Data Analysis	Performs exploratory data analysis on the stored data	pandas (pd), numpy (np), hvplot.pandas
Dashboard	Creates interactive dashboards to visualize the data	panel (pn), hvplot.pandas
Jupyter Notebook	Serves as the interface for the entire project	Jupyter Notebook

9. RESULTS AND DISCUSSION





The choice of libraries used in this project, including pandas, numpy, panel, and hvplot, demonstrates the power and versatility of Python in handling, analyzing, and visualizing data. Pandas and numpy are used for data collection, processing, and analysis, while panel and hvplot are used for creating the dashboard and plots.

One of the key features of this project is the interactive dashboard created using the panel library. The dashboard includes a sidebar with markdown text and an image, and a main area with two rows of plots and tables. This layout provides a clear and organized view of the data, making it easy for users to navigate and understand the information presented.

The use of hvplot for creating the plots adds an extra layer of interactivity to the dashboard. Users can hover over the plots to see more detailed information, making the data exploration process more engaging and informative.

10. CONCLUSION

The results of this project are highly dependent on the data used. However, assuming the data is accurate and up-to-date, the dashboard should provide valuable insights into world CO2 emissions. Users can explore trends in emissions over time, compare emissions between different countries, and understand the impact of various factors on emissions.

The interactive nature of the dashboard allows users to delve deeper into the data and draw their own conclusions. For example, they might discover that certain countries have significantly reduced their emissions over time, while others have not. They might also find correlations between emissions and other factors, such as population size or economic development.

In conclusion, this project represents a significant step towards leveraging technology to address global environmental issues. It demonstrates how data visualization tools can be used to communicate complex data in a simple and understandable way, thereby contributing to the global efforts to mitigate climate change

11. APPENDIX

```
public class CarbonEmissionData {
    private String country;
    private int year;
    private double emission;

    public CarbonEmissionData(String country, int year, double emission) {
        this.country = country;
        this.year = year;
        this.emission = emission;
    }

    // Getters and setters
}

import java.util.ArrayList;
import java.util.HashMap;
import java.util.List;
import java.util.Map;

public class EmissionDataManager {
    private Map<String, List<CarbonEmissionData>> emissionDataMap;

    public EmissionDataManager() {
        this.emissionDataMap = new HashMap<>();
    }
```

```
    public void addEmissionData(String country, int year, double emission) {
        CarbonEmissionData data = new CarbonEmissionData(country, year, emission);

        emissionDataMap.computeIfAbsent(country, k -> new ArrayList<>()).add(data);
    }

    public List<CarbonEmissionData> getEmissionDataList(String country) {
        return emissionDataMap.getOrDefault(country, new ArrayList<>());
    }

    public List<String> getAvailableCountries() {
        return new ArrayList<>(emissionDataMap.keySet());
    }
}

import javafx.application.Application;
import javafx.collections.FXCollections;
import javafx.collections.ObservableList;
import javafx.scene.Scene;
import javafx.scene.chart.LineChart;
import javafx.scene.chart.NumberAxis;
import javafx.scene.chart.XYChart;
import javafx.scene.control.Button;
import javafx.scene.layout.HBox;
import javafx.stage.Stage;

public class CarbonEmissionDashboard extends Application {

    private EmissionDataManager emissionDataManager;
```

```
    public static void main(String[] args) {
        launch(args);
    }

    @Override
    public void start(Stage primaryStage) {
        emissionDataManager = new EmissionDataManager();

        primaryStage.setTitle("Carbon Emission Dashboard");

        Button viewEmissionButton = new Button("View Emission Data");

        LineChart<Number, Number> lineChart = createLineChart();
        HBox hbox = new HBox(10);
        hbox.getChildren().addAll(viewEmissionButton, lineChart);

        viewEmissionButton.setOnAction(e -> {
            populateChartData(lineChart, "Country1"); // Replace "Country1" with the
selected country
        });

        Scene scene = new Scene(hbox, 600, 400);
        primaryStage.setScene(scene);
        primaryStage.show();
    }

    private LineChart<Number, Number> createLineChart() {
```

```
        NumberAxis xAxis = new NumberAxis();
        NumberAxis yAxis = new NumberAxis();
        xAxis.setLabel("Year");
        yAxis.setLabel("Emission");

        return new LineChart<>(xAxis, yAxis);
    }

    private void populateChartData(LineChart<Number, Number> lineChart, String
selectedCountry) {
        lineChart.getData().clear();

        List<CarbonEmissionData> emissionDataList =
emissionDataManager.getEmissionDataList(selectedCountry);

        if (emissionDataList.isEmpty()) {
            return;
        }

        XYChart.Series<Number, Number> series = new XYChart.Series<>();
        series.setName(selectedCountry);

        for (CarbonEmissionData data : emissionDataList) {
            series.getData().add(new XYChart.Data<>(data.getYear(), data.getEmission()));
        }

        lineChart.getData().add(series);
    }
}
```

```
import javafx.scene.control.ComboBox;

// Inside the start method
ComboBox<String> countryDropdown = new ComboBox<>();
countryDropdown.getItems().addAll(emissionDataManager.getAvailableCountries());
countryDropdown.setPromptText("Select a Country");

countryDropdown.setOnAction(e -> {
    String selectedCountry = countryDropdown.getValue();
    populateChartData(lineChart, selectedCountry);
    populateTableView(selectedCountry);
});

hbox.getChildren().add(countryDropdown);

import javafx.collections.FXCollections;
import javafx.scene.control.TableColumn;
import javafx.scene.control.TableView;
import javafx.scene.control.cell.PropertyValueFactory;

// Below the lineChart declaration
TableView<CarbonEmissionData> tableView = new TableView<>();

TableColumn<CarbonEmissionData, Integer> yearColumn = new
TableColumn<>("Year");
yearColumn.setCellValueFactory(new PropertyValueFactory<>("year"));

TableColumn<CarbonEmissionData, Double> emissionColumn = new
TableColumn<>("Emission");
```

```
emissionColumn.setCellValueFactory(new PropertyValueFactory<>("emission"));

tableView.getColumns().addAll(yearColumn, emissionColumn);

hbox.getChildren().add(tableView);

private void populateTableView(String selectedCountry) {
    tableView.getItems().clear();

    List<CarbonEmissionData> emissionDataList =
emissionDataManager.getEmissionDataList(selectedCountry);
    ObservableList<CarbonEmissionData> data =
FXCollections.observableArrayList(emissionDataList);
    tableView.setItems(data);
}

import javafx.scene.control.Menu;
import javafx.scene.control.MenuBar;
import javafx.scene.control.MenuItem;
import javafx.stage.FileChooser;

// Inside the start method
MenuBar menuBar = new MenuBar();
Menu fileMenu = new Menu("File");

MenuItem saveItem = new MenuItem("Save Data");
saveItem.setOnAction(e -> saveData());

MenuItem loadItem = new MenuItem("Load Data");
```

```
loadItem.setOnAction(e -> loadData());

fileMenu.getItems().addAll(saveItem, loadItem);
menuBar.getMenus().add(fileMenu);

hbox.getChildren().add(menuBar);

private void saveData() {
    // Implement logic to save data to a file (e.g., using serialization or JSON)
}

private void loadData() {
    // Implement logic to load data from a file (e.g., using deserialization or JSON
parsing)
}
```

12. REFERENCES

1. **co2-emissions · GitHub Topics · GitHub**
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5. **Mzkarim/Exploring–CO2-Emission-Data- - GitHub**
6. **Data Analysis and Visualization of Co2 Emission by Different … - Medium**
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