04-638: Programming for Data Analytics

Homework Report

WORLD CO2 Emission Analysis

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Abstract

The rising emissions of carbon dioxide (CO2) is a global concern that affects every aspect of modern life. Carbon dioxide (CO2) is a waste product of energy production that is primarily released into the atmosphere when fossil fuels like coal, gasoline, and natural gas which are used to generate electricity and heat are burned. This colourless gas is invisible to the eye, but it has a big impact on Earth's climate balance.

Background and Problem Description

The need for energy rises is direct proportion to the number of people on the planet, beginning an unending cycle of rising CO2 emissions. CO2 emission is a global issue that requires a comprehensive response. The shift to renewable energy, improved energy efficiency, and adoption of sustainable practices are all essential elements of a larger effort to lessen the effect of human activity on climate change. It is impossible to exaggerate how urgent this work is, since unchecked CO2 emissions have effects on ecosystems, biodiversity, and the welfare of future generations in addition to the composition of the atmosphere[1]. The world is at a turning point in its response to the problems caused by rising CO2 emissions. Societies must come together with a common commitment to sustainable development to promote a peaceful coexistence of environmental preservation and human advancement. Given a dataset of Recorded gas emission of different countries of a period time. We want to analyse the Data and try to understand how the emission has fluctuated and how different countries have contributed to that.
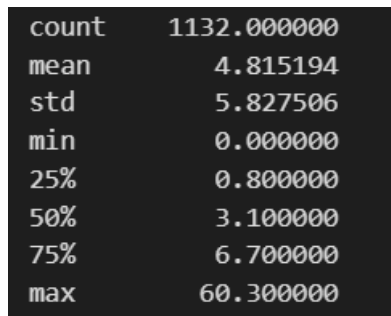
Methods

Data Pre-Processing:

To understand our Dataset, we first preformed some basic Data pre-processing including displaying column names we have in our dataset to understand what each column represents. Our dataset has 8 columns including:

- Country/region/Area: This column in our dataset has numerical labels representation of each row to identify same rows that have data records in different periods, they are 149 countries recorded in this Dataset
- Country: This column has different unique countries names whose data that have been recorded the country are duplicated reason being that there is different year that are recorded form the same countries.
- Year: This is the column which contain years that the data were recorded for different countries. The years range from 1975 to 2020.
- Series: The column series contain a metric that was used to record Co2 emission we have two main metrics including: (Emissions (thousand metric tons of carbon dioxide), Emissions per capita (metric tons of carbon dioxide)) the first metric records carbon per a thousand metric tons and the second records the emission per individual in specific country.
- Value: This is the column that has records of Co2 emissions with both per capita and per thousand metric tons.
- Footnotes: This column provide special information on specific countries records as an example "That from China doesn't not include Hongkong" This means that Hongkong and China are separated while recording the Emission of Co2. Additionally, this column provides special note on new-born countries.
- Sources: This is the column that provide information on the course of the records of carbon emission for each country.
- Unamed7: With motives that this column has several missing values we decided to drop it.
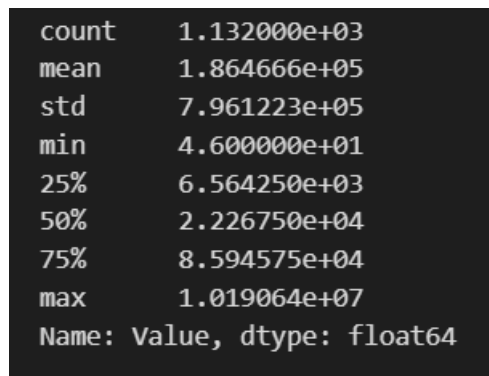
Descriptive Statistics:

Leveraging the Pandas built in function "Describe" We computed statistical mathematical measurements on the Column Value, below are the results.

The figure below shows the number of records per capital the dataset has for all countries, and the average of co2 emission for all countries in a period of 197-2020 is: 4.8. Where the minimum value of emission is 0 and the Maximum value recorded is 60.3. The Standard deviation which gives insight on how the datapoint deviated from the Average (Mean) is 5.8.

The figure below Describe the statistic of record per thousand metric tons for all countries. The Maxim record in the Whole Dataset from the year 197-2020 is 10190640. The minimum value record is 46. The average of the whole recorded co2 emission is 18646 where the deviation of the data point to the Mean is 79612.

We have asked ourselves 10 different questions, while leveraging the Data and the power of visualization will try to answer those questions. Here are the questions:

1. **What is the first year of recording emission and the recent year that was recorded, and what is the countries with the highest co2 emission at the beginning of the record and what do they have in common?**
   From our Dataset the Earliest year that was recorded was 1975. Between 1850 and 1960, global carbon emissions witnessed consistent growth, primarily driven by industrialization and population expansion, notably in the United States. This upward trend was occasionally disrupted by significant historical events such as the end of World War II in 1945. However, by the 1950s Asian nations, led by China, also started to play a prominent role in this trajectory[2]. The provided graph illustrates the emission trends of the current top five co2 emitting countries since 1975. These were more developed and had industrial revolutions already.
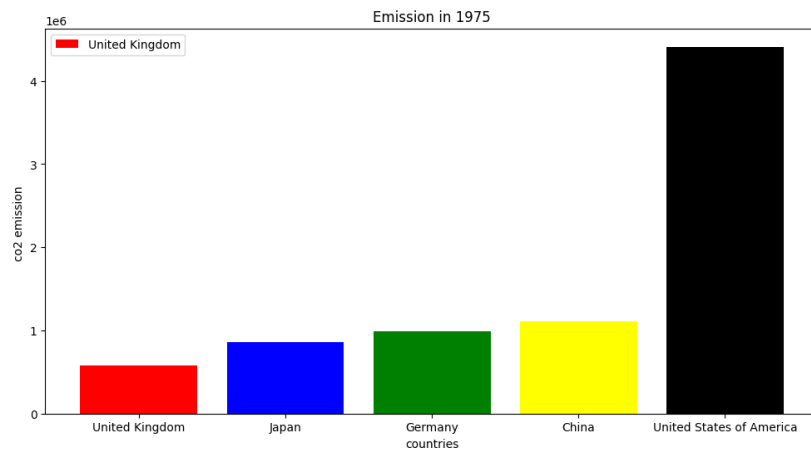
Figure 3: Top 5 countries with highest Emission of Co2 in 1975

2. comparison of co2 emission in 2019 and 2020

We want to understand if there was any reduction of co2 emissions in the most developed countries, due to the Pandemic crisis, where lockdown was force and company shutdown. Since Most of our Daily life activity and transport depends on energy and fuel burning was there any change Most of the Activities were stopped during the Pandemic. From [3] It is said that the need of energy reduce by 4% globally and the emission dropped by 5.8% . From the Graph The was a reduction of Co2 Emission for all top 5 co2 emitters country apart from China.
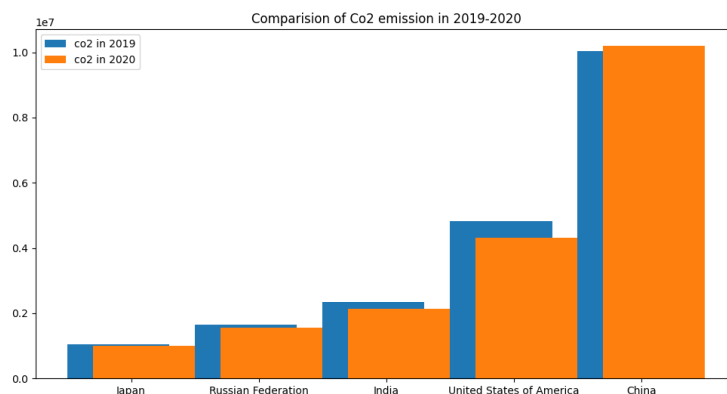

Figure 4: Comparison of c02 emission in 2019-2020

3. Lowest co2 ever emission per metric for all period in the Dataset

After Plotting countries with the highest Co2 Emission We want to know what countries with the Minimum co2 emission per Metric for the Whole period in the Dataset. We Have grouped the Dataset per metric ton and grouped them per years Where each country will be associated with all the years recorded. We then iterated in the Dataset on a condition to return the country with the minimum co2 emission in that particular year. We found two countries Which are Equatorial Guinee. Co2 emissions by Equatorial Guinee has been sharply decreasing over a period of time where in 2019 it decreased on a percentage of 10.79%[4]. The second country is Gibraltar, this a British overseas territory. Compared to Equatorial Guinee Gibraltar has a highest emission.
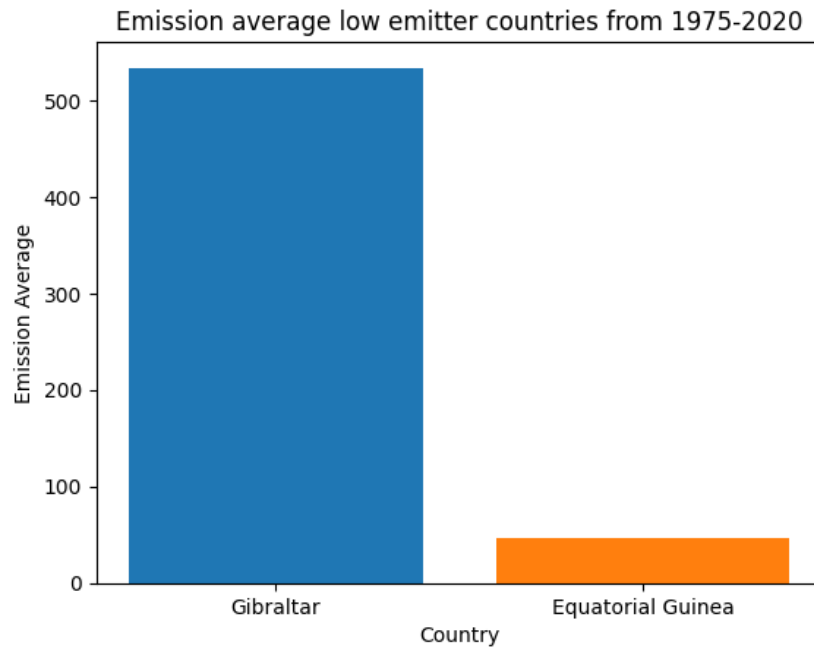
Figure 5:Average of Low co2 Emitter (197-2020)

4. Time series data for carbon emission

With this dataset we can understand how co2 emission increase over time counting all the countries. We can infer that as years pass the increase of co2 emission into the atmosphere increase. This is due to various factors, there were built of many nuclear powers plant and more vehicles companies created increased in function of years. Additionally, the need of energy increased as the world become more densely populated. On the account that the world is increasing in population many trees have been cut down to make space for construction and more infrastructure building , as we know from our biology classes trees absorbs co2 in the air and release the o2 from the photosynthesis process, so the cut down of trees and deforestation in many region has contributed to the increase of Co2 emission[5].
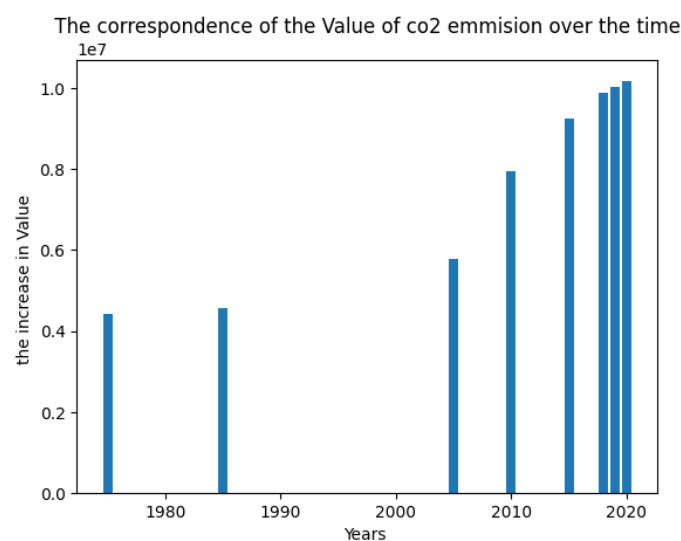

Figure 6: Increase of co2 over period

Conclusion

To conclude, Co2 emission is a fatal challenge we are facing in this era, we have seen major change in our Climate ecosystem and environment. In addition, earth warm temperatures have rose as a result the glaciers in the north pole has been melting here rising the sea level. This has cause vanishing of different small island mainly in The Pacific region and other region[6]. All in all, the Assignment has help us in Understanding the importance of visualization and what are the appropriate type of visualisation to use, we have also understood the impact of co2, and we were able to infer major countries that contribute to co2 emission.

Reference:

[1] L. J. R. Nunes, 'The Rising Threat of Atmospheric CO2: A Review on the Causes, Impacts, and Mitigation Strategies', *Environments*, vol. 10, no. 4, Art. no. 4, Apr. 2023, doi: 10.3390/environments10040066.

[2] J. Friedrich and T. Damassa, 'The History of Carbon Dioxide Emissions', May 2014, Accessed: Nov. 16, 2023. [Online]. Available: https://www.wri.org/insights/history-carbon-dioxide-emissions

[3] 'Global Energy Review: CO2 Emissions in 2020 – Analysis', IEA. Accessed: Nov. 16, 2023. [Online]. Available: https://www.iea.org/articles/global-energy-review-co2-emissions-in-2020

[4] 'Equatorial Guinea Carbon (CO2) Emissions 1990-2023'. Accessed: Nov. 16, 2023. [Online]. Available: https://www.macrotrends.net/countries/GNQ/equatorial-guinea/carbon-co2-emissions

[5] 'Main sources of carbon dioxide emissions | CO2 Human Emissions'. Accessed: Nov. 16, 2023. [Online]. Available: https://www.che-project.eu/news/main-sources-carbon-dioxide-emissions

[6] 'Islands That Have Disappeared: A Tragic Loss to the World | GVI'. Accessed: Nov. 16, 2023. [Online]. Available: https://www.gvi.ie/blog/smb-islands-that-have-disappeared-a-tragic-loss-to-the-world/